



3 1761 04900065 6

Psych. 490  
I4C5  
cop.2

QK  
490  
I4C5  
cop.2



Amount  
Bibliot  
Bender  
Ford Bros.  
makers  
use, N. Y.  
AN 21, 1908

INTRODUCTION TO THE SYSTEMATY OF  
INDIAN TREES

By

A. H. CHURCH, M.A.

HUMPHREY MILFORD  
OXFORD UNIVERSITY PRESS  
LONDON EDINBURGH GLASGOW COPENHAGEN  
NEW YORK TORONTO MELBOURNE CAPE TOWN  
BOMBAY CALCUTTA MADRAS SHANGHAI

1921

*Price Two Shillings and Sixpence net*

Digitized by the Internet Archive  
in 2008 with funding from  
Microsoft Corporation

Bot.  
flora  
C.

75

BOTANICAL MEMOIRS. No. 12

INTRODUCTION TO THE SYSTEMATY OF  
INDIAN TREES

By  
A. H. CHURCH, M.A.

191466  
10.10.24.

HUMPHREY MILFORD  
OXFORD UNIVERSITY PRESS  
LONDON EDINBURGH GLASGOW COPENHAGEN  
NEW YORK TORONTO MELBOURNE CAPE TOWN  
BOMBAY CALCUTTA MADRAS SHANGHAI

1921

QK  
490  
I4C5  
cop. 2

51111-20  
107

## CONTENTS

	PAGE
I. INTRODUCTION . . . . .	3
II. APOCARPOUS FAMILIES . . . . .	6
III. CISTIFLORAE (Dilleniaceae, Bixaceae) . . . . .	9
IV. CISTIFLORAE (Guttiferae, Dipterocarpaceae) . . . . .	12
V. MALVALES . . . . .	15
VI. DISCIFLORAE (Geraniales) . . . . .	18
VII. DISCIFLORAE (Sapindales) . . . . .	21
VIII. LEGUMINOSAE . . . . .	24
IX. CALYCIFLORAE . . . . .	27
X. BICARPELLATAE . . . . .	30
XI. EUCYCLIC GAMOPETALAE: INFERRAE . . . . .	33
XII. APETALAE . . . . .	36
XIII. MONOCHLAMYDEAE (Urticales) . . . . .	39
XIV. MONOCHLAMYDEAE (Cupuliferae, &c.) . . . . .	42
XV. PALMAE . . . . .	45
XVI. GRAMINEAE: GYMNOSPERMS . . . . .	48

---

These notes have been arranged for the use of a class in Indian Botany, which has been held at the Botanic Department for Indian Forestry Probationers during recent years. The text sufficiently expresses the narrow limitations of the material and time available; it has been collected in the present form of 16 lecture-schedules, as affording a working draft for further amplification by students, in view of the bulky and expensive nature of more official publications: also as being something in hand, which, however imperfect, may serve as the beginning of a more definitely modern course of Tropical Botany.

BOTANIC GARDEN, OXFORD, *July*, 1921.



**INDIA** comprises a botanical region of essentially Asiatic and tropical continental area, ranging from primary evergreen rain-forest to the limit of Alpine plant-life at the higher elevations of the Himalya, including sub-equatorial swamps, mountain rain-forest and the deciduous monsoon-forest of drier central tracts, the vegetation of grassy plains, estuarine mangrove-formation, sandy sea-coast, savannah and park-lands, as well as tracts of dry arid sandy or stony desert, and affording examples of all types of tropical vegetation and cultivation.

Such may serve as an introduction to the optimum ecological regions of the present world, on a scale and of a character wholly distinct from the impoverished vegetation of more northern latitudes, and the mediocre types of European or indigenous flora, which have long served as the elementary review of Systematic Botany. Under such optimum conditions plant-life may be still dominant, as well as enormously preponderant. Much of the area has produced forest continuously throughout known geological time ; competition and natural selection continue to act on an intensive scale.

Botanical interest centres in **forest-formation**, as expressing the infinite possibilities of combination of the same generalized features of somatic organization in response to extreme biological factors as intensive insolation, problems of water and food-salt supply, perennation over intense drought, the protection of the reproductive processes and of the developing seeds, the possibility of dispersal to unoccupied ground or of active competition in closed formations, and the critical stages of the successful germination of the embryo, as also of its juvenile condition.

The most characteristic feature is **intense insolation**, which gives practically unlimited supplies of photosynthetic carbohydrate, in excess of the possible capacity for further proteid-synthesis, dependent in turn on the food-ions of the water-supply. Waste polysaccharide is utilized in timber-production and xerophytic protective mechanism of sclerosed strands and layers, conspicuous also in massive capsules or sclerosed indehiscent fruits, as again in the production of starch or hydrocarbon fat and oil, giving enhanced possibilities of 'food-storage' for embryos in germination, or again as the sugars and organic acids of large succulent fruits utilized for the dispersal of seeds by animal agency.

Increased rates of metabolism follow **higher temperature**. Foliage-leaves may be reckoned in feet instead of inches, and the same applies to the development of the annual shoot. Flowers range to huge mechanisms, or may be reduced to the merest vestiges of economized systems. Pollination by bee-agency is less predominant in forest-formation ; small mechanisms are associated with flies and insects with short proboscides ; larger mechanisms grade to moth and bird-visitation.

**Water-supply**, regarded not only as the essential component of the dilute medium of living plasma, but also as the source of food-ions, is the primary factor in promoting ecological formations, and determining the evolution of types of higher grade, according as the supply may be permanent, casual, seasonal, or practically non-existent. Methods of economizing the available supply become the rule, as few plants do not feel the strain at some time of the year, day, or of their individual life. Similarly all advancing stages of the ovary-chamber, which marks the evolution of the Angiosperm gynoecium, from the primary closing in of free megasporophylls to phases of syncarpy and the elaboration of the inferior ovary, are to be approached from this standpoint. The case of the 'green-fruit' affords conspicuous illustration. In evergreen rain-forest, flowers and fruits of the upper exposed levels, competing with the foliage-leaves for water-supply, present advanced xeromorphic mechanism. In seasonal deciduous monsoon-forest green fruits subserve seed-protection into the driest months of the year, with increased devices of osmotic water-storage, sclerosed layers of massive ovary-wall, packing of the internal cavity with dry or succulent hair-growths, succulent seed-arils, or lamellar extensions, the production of terpenes,

glandular hairs, spinous emergences, wing-like shading laminae—all as mechanisms capable of subsequent utilization, more or less successfully, in the dispersal of fruits and seeds. Minor examples of such phenomena in trees of Northern latitudes illustrate the fact that all such adaptations were originally attained during the rigorous selection implied in solving the problems of tropical vegetation.

**Forest Trees**, taken as plants with perennial woody habit, ranging from small shrubs and climbers to massive timber-trees of high forest, are scheduled at 4,400 species (Brandis, 1911), those giving appreciable timber at 1,450 (Gamble, 1902), as economically significant to the forester, 300 (Troup, 1913), and at least 200 may be regarded as generally important.

**Systematy**: For purposes of cataloguing and ready reference, plants are classified in groups and sections (phyla), to families, genera, and species, the main outlines of which are still more or less empirical and largely traditional, though aiming at a 'Natural System'; i.e., one expressing genetic relationship. The recognition of even a 'species' is still arbitrary, and all classification may be regarded as provisional. The morphological organization of the flower, fruit, and seed, as including the complex processes of *racial mechanism* of reproduction, is generally utilized; since this covers the elaborate provision for the specialization of the floral shoot-system and its mechanism, as concerned with:—(1) the essential process of cross-pollination, or the approximation of the microspores to the vicinity of the megasporangium of the sporophyte-phase; (2) the elaboration of the ovary-chamber as the special feature of the Angiosperm; (3) the mechanism of seed and fruit-formation as allotted to post-sexual nutrition and the care of the embryo; and (4) the structures associated with the dispersal, perennation, and germination of the seed. So complex and inter-related are the adaptations for these several functions, taken singly or in combination, that the somatic organization of the general vegetative and arboreal growth, its morphology and relation to insolation and desiccation, as expressing the more immediate relation of the *individual* to its present environment, become of relatively subsidiary importance. Such data may be still significant in lesser degree; since though they are equally the ecological inheritance of past ages, they appear on the whole less conservative in obscure mechanism, through which may be traced older factors in the evolution of flowering and seed-plants of more remote epochs.

**Systems of Classification**, though now admittedly aiming at phyletic presentation, are not to be criticized too strictly in this direction. A 'System' is the official presentation of the subject at any given time, with which the individual botanist has little to do. Cataloguing and bookkeeping have to be maintained as a common standard of reference. The limitations of *species*, *genera*, and *families* are commonly accepted, though subject to minor sources of error; these become the units of systematy. Official systems only differ as they reflect more modern outlooks for regarding the grouping and terminology of the larger sections. The arrangement of the latter in any linear sequence for book-presentation is largely a matter of convenience and convention.

**Natural Classification** aims at the arrangement which may most clearly visualize the phyletic progression of different races; but the life of every higher plant involves the balanced compromise in the solution of quite a number of distinct problems, each requiring a set of complex specialized mechanism, adapted from the remains of past mechanisms of older phases of existence. Hence every race, genus, and species may show independently combined lines of evolutionary progression, or even of deterioration, in many different directions differently, or at unequal rates. No very primitive or archaic plant can be now in existence: all may be highly organized in different respects, or present different horizons of attainment in the same category. All systematy thus ends in being artificial to some extent, and convenience is more important than pedantic discussion; after all, systematy is made for the advance of scientific botany, not *vice versa*, and classification can no longer be regarded as an end in itself.

**The Modern System**, based on the Natural System of Jussieu (1789), extended



by De Candolle (1818-73), has been officially organized in the *Genera Plantarum* of Bentham and Hooker (Kew, 1862-83), and further emended and extended in the *Pflanzenfamilien* of Engler and Prantl (Berlin, 1889-1908). Pending a further revision of the whole field by an accepted and competent authority, the text of the last stands as the ultimate appeal.

For purposes of general investigation a method of **Plant Description** is required, expressed in concise and readily intelligible phraseology, a method of interpretation of floral construction in terms of a **Floral Diagram**, and again as scale-drawings in **Sectional Elevation**: in addition, data for time-factors, and details of the working mechanism in relation to insects and other external agencies, the structural details of the fruit, and the biology of seed-dispersal. Much of the older literature is expressed in obsolete terminology which reflects antiquated points of view. Hence new descriptions, in plain English, new figures, and especially accurate data for floral biology and general ecology are urgently required; and the field is limitless.

**The Genera Plantarum** of Kew, though obsolete botanically, is still largely official for British Government Departments. For present purposes the compromise adopted by Brandis (1911) will be followed as far as possible; this being so far the official presentation for Indian foresters. Large, well-differentiated petaloid flowers are conveniently dealt with first; smaller reduced, or more elementary forms presenting greater difficulty, may be taken later. Hence Polypetalous Thalamiflorae are followed by Eucyclic Disciflorae, and these by Calyciflorae. The Gamopetalae ('Sympetalae') in turn by Monochlamydeae which comprise a mixture of some possibly more archaic types with many undoubtedly reduced and secondarily 'apetalous'. Monocotyledons, as of minor arboreal importance are left till last, though containing phyla of extremely divergent and advanced organization; and some reference is made to Gymnosperms.

Though often minimized in Modern Botany, a practical acquaintance with a wide range of Angiospermous plants, their nomenclature and classification, is still an integral part of the equipment of every working botanist; as an intimate knowledge of the living plant in all its phases and mechanism is the only sure basis for all economic or technological exploitation of available natural resources of the plant-kingdom, on which the human race is still wholly dependent. The broader lines of geographical ecology, as also methods of culture and the utilization of economic products, are referred to standard text-books on Indian forestry:—

For **General Literature**, cf. :—

*Brandis* (1911), Indian Trees.

*Gamble* (1902), A Manual of Indian Timbers.

*Troup* (1913), Indian Forest Utilization.

*Troup* (1921), The Silviculture of Indian Trees.

*Schimper* (1903), Plant Geography, Eng. Trans.

*Engler-Prantl* (1889-97), Pflanzenfamilien.

For **Illustrations**, cf. the older floras :—

*Wight* (Madras, 1840-50), Illustrations of Indian Botany, 2 vols.

*Wight* (Madras, 1840-50), Icones Plantarum Indiae Orientalis, 6 vols.

*Roxburgh* (1795), Plants of the Coast of Coromandel, 3 vols.

*Beddome* (Madras), The Flora Sylvatica for Southern India, 2 vols.

*Wallich* (1830), Plantae Asiaticae Rariores, 3 vols.

*Brandis* (1874), Illustrations of the Forest Flora of North-West and Central India.

**APOCARPOUS FAMILIES** are usually approached from the standpoint of the Ranunculaceae (27/1200) of the N. Temp., but these are typically herbaceous types and are wanting in tropical forest: *Clematis* (170) alone is woody, including liana-forms climbing by leaf-petioles: cf. *C. montana* of Himalya, climber flowering in spring on short spur-shoots; flowers 2-3 in. diam.; perianth-segments 4 (5-6), white; stamens 100-130; carpels 40-50, each with 1 functional ovule and rudiments of others; fruit as a cluster of achenes, 1-seeded, with long hairy style enlarged and assisting in wind-dispersal. *C. lanuginosa*, China, with many vars. and hybrids (Hort.); flowers large, solitary, terminating spring shoots, 6-8 in. diam.; per. seg. 6-8, pale violet-blue; stamens 100-200, carpels 100-120; fly pollinated, with large achenes and long style persistent.

**Magnoliaceae** (9/100), essentially a family of tropical and sub-tropical trees, founded 1818. These afford the nearest approximation to the general conception of what primitive Angiospermous flowering trees may have been in the past; hence appropriately begin the system.

*General features*; leaves large and simple, with a sheathing stipule-construction enclosing the next younger members. *Flowers* solitary and terminating the foliage-shoot, usually large and conspicuous, hermaphrodite, spirally constructed and indefinite. *Perianth* trimerous, of the type 3+3+3; *Floral receptacle* elongated and presenting distinct zones; *Androecium* of many stamens, separated from the gynoecium of numerous free carpels; the latter each reduced to a small ovary with 2 or more ovules, and with prolonged stigmatic tip. Usually protogynous and pollinated on first expansion by flies. *Fruit* ranging from dry dehiscent follicular type (usually dehiscing by the outer edge) to achenes; *seeds* with a small embryo in endosperm storing fatty oil.

As available forms cf. :—

*Magnolia conspicua* of Japan (Hort.), flowering on the bare branches March, April, 3-4 in. diam., perianth-segments white; stamens 50-60, with massive filaments; floral receptacle to 30 mm. long; carpels 60, each 2 ovules; mechanism markedly protogynous, not setting fruit (Hort.).

*M. grandiflora* of N. Amer., 60-80 ft. (Hort. in vars.); leaves large, evergreen, coriaceous, stipule 3 in.: Flowers 6-8 in. diam., strongly scented, fly-pollinated; often semi-double; stamens about 60, carpels 50; seeds 1-2, the compact dry set (3-4 in.) of pods (30 mm.) dehiscing by external margin as well as by inner suture.

*Liriodendron Tulipifera*, Tulip Tree of N. Amer. and W. China, Hort.; handsome tree, 160 ft. and 8-10 diam., with deciduous characteristically 4-lobed leaves, and broad flat adpressed stipule pair, 1½ in.; Flowers (June) solitary, 3 in., per. seg. greenish-yellow with red flush, stamens 40, carpels 100; fruit as indehiscent samaroid achenes with wing-prolongation, 2½ in., 1-2 seeded.

Indian forms include species of *Magnolia* chiefly from Himalyan regions.

*Magnolia Campbelli*, a large deciduous tree of E. Himalya; flowers on bare wood in manner of *M. conspicua*, 6-10 in. diam., white or rose-coloured, fragrant; perianth segs. 12-15; fruiting gynoecium elongated to 6-8 in., woody carpels, 12 mm., dehiscing along outer edge, seeds usually 1, red, 10 mm.

*Michelia excelsa*, a tall deciduous tree of E. Himalya (Darjeeling); flowers white, 4 in. diam.; per. seg. 12, trimerous or tetramerous; stamens 100-120, carpels 50-60, on a receptacle 13 mm. long, spaced 5 mm. from androecium; ovules 3-4, stigma hooked; Fruiting portion elongated 4-8 in., lax, with follicular carpels, ½ in., dehiscing on outer edge; seeds 10 mm., with red sarcotesta, taken by birds.

Cf. *M. Champaca*, a large evergreen tree of E. Sub-Himalya and W. Ghats, much cult.; Flowers 2-3 in. diam., fragrant; per. segs. 15, yellow-orange; fruiting receptacle erect, extending to 3-6 in.; dry follicles ovoid, 20 mm., dehiscing by outer margin, seeds 3-5, 10 mm., with pink sarcotesta.

Also note *Talauma Hodgsoni* in Hill-forest, Nepal, more generalized in gynoecium, in fruit this becomes an erect and massive conoid aggregate, 4-6 in., with woody carpels (100 or more), dehiscing normally by 'ventral' suture, and coming away from the axis.

**Anonaceae** (46/800), based on American forms of *Anona* (1808), and extended to a wide range of trees essentially of tropical forest, with simple leaves, exstipulate. Flowers usually hermaphrodite and trimerous in perianth, of the type 3 'sepals', 3+3 'petals', giving floral mechanisms of high specialization, fly-pollinated 'chamber-types', often large and highly-coloured. The floral receptacle is usually *condensed*; the androecium of indefinite stamens with irregular arrangement as a platform of anther-facets; gynoecium indefinite of free carpels, the ovary-region reduced, and a specialized stigmatic surface. In fruit the carpels enlarge, with great range, often long-stalked, 1-seeded or many-seeded, succulent or woody. The seeds are large, with small embryo in a conspicuously ruminated endosperm.

Wholly distinct from Magnoliaceae in fruit and seed-organization, convergent in elementary floral construction with trimerous perianth and small stamens and carpels closely compacted to a platform-mechanism, pollinated in a half-closed bud condition. Indian genera 15, including *Saccopetalum* and *Miliusa* of deciduous forest, *Polyalthia*, *Unona*, *Uvaria*, *Anona*. In the most characteristic floral mechanism the valvate 'petals' close in over the essential organs to constitute a damp protected chamber, access to which is permitted by slits or windows left between the petals. The original dehiscent fruit is seen in *Anaxagorea zeylanica*, a mere shrub; in others it is indehiscent, and each carpel tends to be sclerosed to a sub-spherical nut-like body, often long-stalked; a 'head' of fruits being in such case produced from one flower (*Polyalthia*). In *Anona* the entire aggregate of carpels may become coalescent and succulent, giving an edible many-seeded massive fruit; cf. *A. squamosa*, Sweet-Sop, cult. in tropics; flowers small greenish, 2 in., perianth of type 3+3+3; aggregate of stamens hemispherical; the fruiting gynoecium enlarges to 2-4 in. diam., with seeds in soft succulent pulp: also *A. muricata*, Sour Sop, with pointed carpel-facets, *A. reticulata*, Custard Apple, also cult., fruit with pentagonal facets.

**Canarium odoratum**, evergreen tree, 30-60 ft., of E. Indies, commonly cult.; flowers in racemes of 2-6, drooping on long stalks: calyx of 3 sepals reflexed, corolla 3+3, petals to 3 in. long, yellow, very fragrant and convergent over floral apex to an approximate chamber, ultimately lax. Androecium of about 200 stamens, 2 mm., closely compacted to a button-like mass, 10 mm. across; connective-apex as a spike. Gynoecium of 10-12 carpels; ovary-region with many ovules, and the stigmatic ends enlarged and fused to a central stigmatic head. Mechanism protogynous, fly-pollinated. Fruit a cluster of hard black 'berries' 20 mm., with slight sarcocarp, each containing 6-10 seeds with ruminated endosperm.

**Goniothalamus Griffithii**, a small tree of the South and Burma, with typical flowers: sepals 3 ovate, 9 mm.; petals 3+3, the outer whorl massive, 3 in., leathery; the 3 inner alternating, 2 mm. thick below, 20 mm. long, cohering by valvate edges (with interlocking papillae) to a club-shaped chamber over the essential organs, leaving at the base 3 window-apertures (5 mm.) to the interior. Androecium of about 100 stamens, 3 mm., closely packed. Gynoecium of about 20 carpels, free, closely packed on flat receptacle-apex; ovary 3 mm., with ovules 4-5 seriate; style bent, 3 mm., with stigmatic flap. In fruit the carpels are 1-2 seeded, giving indehiscent berry-like structures on stalks, 1 in.

**Saccopetalum tomentosum** (*Uvaria*), a large tree in Sal forest and South: flowers 2-3 in. long. Fruiting carpels dark-purple, 1 in. diam., on  $\frac{1}{2}$  in. stalks, 3-4 seeded.

**Miliusa velutina**, a tree of C. India and Sub-Himalya, 3 inner petals long, silky and velvety externally, dark-purple inside. Fruit a rounded cluster of stalked carpels, each  $\frac{1}{2}$  in. diam.

**Polyalthia longifolia**, a tree of S. India, planted in avenues; flowers yellowish-green, in umbellate clusters; ripe carpels  $\frac{3}{4}$  in. on  $\frac{1}{2}$  in. stalks.

*Unona discolor*, shrubby; flowers greenish-yellow, 1–2 in.; carpels clustered in fruit, on long stalks,  $1\frac{1}{2}$  in., purple and elongated, 2–5 seeded, and constricted between the seeds. Species of *Unona* and *Uvaria* tend to become climbers.

Of Orders in which the floral organization, though apocarpous, tends to be reduced to minimum constructions in terms of trimery and small size, note:—

**Menispermaceae** (56/260), a family of characteristically stem-twining climbing shrubs, with panicles of numerous small flowers of the type, perianth 3 + 3, the stamens reduced to 3 + 3, and the carpels 3 or 1, with usually one ovule per carpel. The fruits are drupaceous, to  $\frac{1}{2}$  in. diam. The woody stems commonly present anomalous organization of the lianoid-type with broad med. rays, and recurrent cambiums, cf. *Cocculus*, *Cissampelos*.

**Berberidaceae** (8/150), based on the European *Berberis*, present trimerous flowers with ovary of 1 carpel, but with several basal ovules: the anthers dehisce by 2 'valves'. Fruit a berry with 1 or more seeds. Several Indian sp. (14) in Hill-forest as shrubs. *B. vulgaris* in NW. Himalya, &c.

A small series of aberrant forms, *Lardizabalaceae*, monoecious, anthers not valvate, carpels 1–3, apocarpous, ovules over inner surface of wall, cf.:—

**Akebia quinata**, a pretty liana-form (Hort.), with 5-lobed foliage-leaves, and flowers (April) declinous, trimerous, dull purple, in simple racemes. Carpellary flowers few, below and larger; per. seg. 3, carpels 3 + 3 (varying), distinctly apocarpous, with many ovules. Staminate flowers small and numerous; per. seg. 3, reflexed, stamens 3 + 3, anthers dehiscing by slits.

For the Lauraceae, with limiting cases of dicliny, dimery, apetalý, and carpellary flower with 1 carpel and 1 ovule, but comparable valvate anthers, cf. 'Apetalous families', p. 36.

**CISTIFLORAE** in the wider sense conveniently include a vast range of types in which the fully petaloid flower attains a normal pentamerous calyx and an apparently whorled corolla; the androecium remains wholly indefinite, but the gynoecium becomes *syncarpous*, either by a gamocarpous zone to constitute a new unilocular ovary-chamber with *parietal placentation*, or by pocket-formations to a plurilocular condition with placentation *axile*, or ultimately *basal*. The carpels remain vestigial as mere stigmatic lobes, or may be wholly lost. Forms with unilocular ovary and parietal placentation may be conveniently taken first (cf. Cohort Parietales, *Gen. Plant.*, 1862).

In N. Temp. flora the series is commonly approached by the small group of Cistaceae (4/160) on which it was originally founded, based on the Mediterranean forms of *Cistus*; and again from the specialized families of the Rhoeadineae, more particularly as familiar in the special limiting cases of the Crucifer and Poppy.

The alternative line of progression with axile placentation, familiar in Hypericaceae, may be extended to the great tree-families of Guttiferae, Ternstroemiaceae, Dipterocarpaceae.

The Malvales alliance may be considered separately. Probably the oldest phase of the progression is to be traced in Dilleniaceae which remain predominantly apocarpous, and hence come at an early stage in older classifications (*Gen. Plant.*, 1862).

I. The **Dilleniaceae** (11/300), commemorating Dillenius, professor at Oxford, 1734-47, founded 1818, based on the remarkable type:—

**Dillenia indica**, a middle-sized tree of moist regions, cult., with large evergreen serrated foliage-leaves, and fine solitary white flowers, 6-10 in. diam.; sepals quincuncial, thick and fleshy; petals 5, flimsy and fugitive; stamens indef., all alike and inarching; carpels in a single cycle, 15-20, fused along the massive conoidal receptacle, but free laterally, essentially apocarpous, with many ovules. The free white styles are linear and recurve over the golden-yellow androecium.

In fruit the gynoecium enlarges with the growth of the seeds (8 mm.) with little change; the massive sepals close over the carpels to give a succulent acid mass, 4-6 in. diam., and more than 1 in. thick over the enclosed carpels and seeds. Floating on water, eaten by elephants, but essentially for xerophytic protection of seeds on ground in hot season; seeds in protective mucilage; germination on the ground *in situ*, assisted by ants.

**D. pentagyna**, a small tree of deciduous forest, 60-70 ft.; foliage-leaves 2-4 ft. Flowering in March, April, before the leaves: flowers yellow, 1 in. diam., in clusters from tuberos spurs on the older wood; reduced in number of parts; androecium of indef. outer stamens, erect and extrorse, with inner series of 10 recurved anthers on longer filaments. Gynoecium of 5 (6) carpels, free laterally, on a steeply conical receptacle, ovules numerous; styles free, long and reflexed over androecium. Fruit with persistent sepals, 1 in., orange-yellow, taken by birds, similarly enclosing soft indehiscent carpels, each maturing 1 seed.

Cf. *D. scabrella*, very similar, flowers 1½ in. diam.; androecium of about 100 stamens, outer series 90, inner 10-12 reflexed over preceding; gynoecium of 5-6 carpels, free laterally, but cutting in transverse section as if with axile placentation owing to elongation of receptacle. Flowers give pollen only and are nototribal to insects crawling over the lower extrorse anthers.

II. **Bixaceae** (4/20) a small order separated from Cistaceae by the leaves being spirally arranged instead of decussate, based on the monotype—

**Bixa Orellana**, a shrub, indig. to Central America and cult. (Arnatto). Flowers 1-2 in. diam., white or pink, of generalized Cistifloral habit. Petals flimsy, 1 in.; stamens 200-300, with slender filaments as tassel-cluster, on a distinct collar-zone around the ovary. Gynoecium syncarpous, of 2 median carpels; the ovary, 3 mm., covered with emergences; style stout, 13 mm., ovules many, on 2 parietal placentas.

Flowers offer pollen only; fruit a large dry bristly capsule (40 mm. by 30) opening by 2 valves along commissural lines. Seeds 20-25 on each placenta, with red succulent investment of papillose testa: endosperm stores starch.

**Cochlospermum Gossypium**, a small deciduous tree with soft spongy wood, of dry stony hill-tracts, the leaves large and palmately lobed, and flowers yellow, 4-5 in. diam. (suggestive of Cotton-plant). Stamens about 150, and 5 deep, on slender filaments: ovary sub-globular, 6 mm., unilocular with 5 enlarged placentas, each with several rows of ovules (in the manner of a Poppy). Style slender, projecting beyond the stamen-cluster. In fruit the ovary enlarges to a fragile pear-shaped capsule, 3-4 in., and the seeds are clothed with long silky packing hairs, wind-dispersed. A remarkable xerophytic type, convergent with *Gossypium* of Malvales.

Reduced forms with dioecism have been referred to Flacourtiaceae (70/500), cf. :—

**Flacourtia Ramontchi**, a small tree of dry hill districts, with thorny branches and small deciduous foliage-leaves. Staminate flowers small and *apetalous*; sepals 4-5, stamens indefinite, with a glandular extra-staminal disc-nectary and no ovary. Carpellary flower with ovary of 5-11 carpels, placentas meet in centre. Fruit an edible drupe,  $\frac{1}{2}$  in., dark-red, pyrenae in two tiers, bird-dispersed.

**Hydnocarpus Wightiana**, a tall tree of moist forest of W. Ghats and S. India: flowers white, 1 in. diam., dioecious and irregular in construction; stamens 5, stigmas and parietal placentas 3-6. In fruit the ovary enlarges to a spherical hard and woody shell, 2-4 in. diam., indehiscent, with many large irregular seeds,  $\frac{3}{4}$  in., with oily endosperm.

*Taractogenos Kurzii* may be included in the same genus.

III. **Capparidaceae** (34/450) includes some woody shrubs and climbers by stipular thorns. Flowers tetramerous in calyx and corolla, and more or less zygomorphic. Originally based on the Mediterranean—

**Capparis spinosa**, Caper, cult.; corolla cruciform, large and showy, 2-3 in., white and pink later: fugacious, butterfly pollinated with tassel of stamens (60-120). The ovary is extended beyond the anthers on a long *gynophore* (50 mm.), and there is no style: gynoeceum based on 6-8 carpels, with prominent parietal placentas meeting in centre of cavity. Fruit 1-3 in., seeds imbedded in pulpy septa. A highly specialized type in floral construction and biology; as in the parallel Crucifer, the carpels are obsolete and the stigma-lobes commissural and secondary.

Cf. **C. aphylla**, a small tree (20 ft.) of dry regions; flowers red; 1 in. over all; leaves small and shed in hot season. Fruit a red succulent berry,  $\frac{1}{2}$  in. diam., on gynophore stalk, 1 in., taken by birds.

**C. horrida**, scrambling by thorns in hedges, and to a great height. Flowers pink or white, 1-2 in. diam., produced *en masse*. Fruit globose, 1 in. diam.

**Crataeva religiosa**, a small deciduous tree (50-60 ft.) in damp situations and cult.; flowers of typical Capparid habit, pink or yellow, in short terminal racemes, 2 in. diam.: the diagonal petals reflexed posteriorly in zygomorphic presentation; androeceum of 12-20 stamens, filaments 35 mm.; mechanism sternotribal: gynoeceum based on 2 carpels, placentas meet in centre and bear many rows of ovules; gynophore bent forward, 35 mm.: nectary-'disc' as cup-formation, 8 mm. diam. Fruit a sub-globular 'berry', indehiscent, many-seeded, 1-2 in. diam., with hard rind.

IV. **Moringaceae** (1/3) a small order founded for:—

**Moringa pterygosperma**, a small deciduous tree of Sub-Himalya forest-zone, much cult.: leaves large, bipinnate, with small leaflets; flowers in paniced systems, of highly specialized type, in the manner of Capparids but *pentamerous* with a long style. Markedly zygomorphic, with nototribal mechanism, 1 in. diam., white dotted yellow, fragrant. Stamens 10-12; 3 posterior together with 4 alternating staminodes, unite below to a shield-piece over ovary. Gynoeceum a stalked pod from the base of the perigynous receptacle-cup, 4 mm., uniloc., with 3 parietal placentas and many ovules. Style 4 mm., and stigma with 6 minute lobes. Fruit a long pendulous pod,



9-18 in., dehiscing by 3 valves loculicidally, with a single series of large seeds with 3-angled wing-edges, very characteristic, and no endosperm.

V. **Tamaricaceae** (5/100) founded on *Tamarix* of S. Europe, as xerophytic and halophytic small trees, with foliage reduced to small adpressed scale-leaves. Flowers very small, white or pink, in paniced spicate racemes : cf. :—

**Tamarix gallica** of sandy sea-shore (Medit.), Hort. ; flowers typical, pentamerous, 5 mm. over all ; petals pinkish ; stamens 5, with a 10-lobed 'disc'-nectary ; gynoeceium of 3 carpels, with 3 free stigmatic lobes, unilocular cavity, and ovules from 3 basal placentas : in fruit the ovary becomes a small capsule (5 mm.), dehiscing by 3 valves along commissural lines, and the seeds utilize a 'coma' of silky packing-hairs from the chalazal region for wind-dispersal : germinating rapidly on damp ground, but with little vitality.

**T. Troupii**, the common sp. in India (Baluchistan) to 30 ft., gregarious on alluvial tracts, essentially similar. · *T. indica*, halophytic (Sundribans).

**T. articulata**, a middle-sized tree (60 ft. and 2 ft. diam.) of dry regions and inundated land, withstanding extreme range of temperature and drought. End-ramuli shed : flowers loosely paniced on long slender spikes : stamens 5, carpels 3, capsule 3 mm.

A divergent series of the Cistifloral alliance segregating families in which the gynoecium presents predominant *axile placentation*, while the residual carpels are retained as free styles, stigmatic lobes, or may be wholly suppressed. Several large orders of tropical trees, with special characters in other respects are provisionally included.

**I. Guttiferae** (43/820), including Hypericaceae of N. Temp.: otherwise essentially of tropical evergreen forest with characteristic gum-resins, and the vegetative shoots with *opposite* and entire foliage-leaves. The flowers are large and solitary, or small and paniced, ranging to extreme phases of the type of tetramery, dicliny, reduction of ovules per loculus, to the limit of output of one seed per flower. The fruits are commonly indehiscent, dry, or drupaceous; but in some cases dehiscent capsules are still retained, cf. :—

**Hypericum calycinum** (Hort.), giving a good idea of the full type of floral organization (as available indigenous species of the genus illustrate reduction in size and numbers of carpels and stamens). Large blossoms 4 in. diam., terminate woody shoots with persistent, simple, gland-dotted foliage-leaves, more or less D.V. in habit by the twisting of internodes alternately :

*Flowers* actinomorphic, pentamerous, hypogynous; calyx of 5 sepals, obviously quincuncial: corolla of 5 flimsy yellow petals, convolute in prefloration; each with notch, firm outside edge in bud, and crumpled inner lobe: tassel-type of flower giving pollen only: Androecium of 500 stamens, in 5 distinct antipetalous groups shed separately; filaments slender, 25 mm., anthers small: ovary conoidal, 10 mm., of 5 carpels, with free styles, 15 mm., diverging among the stamens, antisepalous: stigmas presented at same distance from axis as the pollen: ovary 5-locular; placentation axile below (parietal above apex of floral axis), with T-headed placentas meeting in centre, and many small ovules. Capsule 20 mm., dehiscent in upper portion by 5 valves (each taking a style); seeds 2 mm., with small straight embryo, and endosperm storing fat.

**Garcinia Mangostana**, as a declinous variant (genus of 180 sp.): evergreen tree, 60 ft., with coriaceous leaves, in general trop. cult. (Mangosteen). Flowers solitary, axillary, or 1-2. Staminate flower rare. Carpellary plant cult. and self-setting: usually tetramerous in calyx and corolla, 2 in. diam., ovary 5-8 locular, stigma peltately lobed: seeds in white pulp of dark-purple fruit with thick resinous hard rind, 2-3 in. diam.

**G. Morella**, S. Ind. and Ceylon, cult. for gum-resin (Gamboge), cf. *G. Hanburyi*; of Siam: flowers small, greenish-white,  $\frac{3}{4}$  in. diam., declinous and tetramerous; staminate flower with a short 4-sided 'column', bearing many short-stalked monothecic anthers: carpellary flower with staminodes and a 4-loc. ovary: fruit  $\frac{3}{4}$  in. diam., with 4 seeds.

**Calophyllum Inophyllum**, evergreen tree of S. Ind. coast-forest, cult.; leaves entire, elliptic, shining coriaceous, with closely parallel lateral veins: flowers declinous, 1 in. diam., cream-white and fragrant, tetramerous: staminate flower with stamens in 4-6 clusters and aborted ovary: carpellary flower similar in diagram, 2 inner sepals larger. Staminal 'bundles' antipet.; ovary of 2 carpels, with 2-lobed stigma and cavity uniloc., with one basal anatropous ovule. Fruit a yellow drupe,  $1\frac{1}{2}$  in. diam., taken by bats, &c.

**C. elatum** (*tomentosum*) Poon Spar tree of S. Ind., to 150 ft., evergreen forest of W. Ghats. Flowers in panicles, 2 inner sepals petaloid.

**Poeciloneuron indicum**, of S. Ind. evergreen forest, more or less gregarious. Flowers pentamerous, stamens 16-20, anthers remarkably 6-10 septate in loculi transversely: ovary of 2 carpels, 2 ovules in each loculus. Fruit  $\frac{3}{4}$  in. dehiscent by 2 valves, 1-seeded.

**Mesua ferrea**, evergreen forest-tree of E. Bengal and Assam, much planted:

Flowers large white and *Cistus-like*, with golden-yellow tassel of anthers, but *tetramerous*; stamens to 1,000 on collar-growth: ovary of 2 carpels, 2-locular, 2 ovules basal in each loculus. Fruit 1 in., woody, 2 valved, shedding 1-4 seeds.

**II. Ternstroemiaceae** (Theaceae, 16/200). A series of more generalized types, the Cistifloral flowers being associated with older spiral leaf-arrangement, the leaves simple, serrate, without stipules, and the plants without resin-glands (leaves not gland-dotted).

**Camellia Thea**, Tea, a shrub or small tree of Assam, planted Ceylon, &c., leaves 1-2 in., flowers white,  $\frac{3}{4}$  in., singly in leaf-axils, pentamerous; stamens 50 or so; gynoecium of 3 carpels with 3 styles and 1 ovule in each of 3 loculi. Capsule 3-angled, dehiscent loculicidally, seeds 3, not winged. Cf. *Ternstroemia japonica*, a large deciduous tree of Hill-forest; *Eurya*, dioecious with indehiscent fruit; *Gordonia* with winged seeds.

**Schima Wallichii**, semi-gregarious in Hill-forest, N. Bengal, 80-100 ft., leaves 4-6 in.: flowers of *Thea*-type, 2 in. diam. Capsule  $\frac{1}{2}$  in., with 3  $\frac{1}{2}$ -in. flat winged seeds.

**III. Dipterocarpaceae** (16/325), a family of fine timber-trees of Indo-Malay, with representative species, many more or less gregarious. Leaves spirally arranged, stipulate; inflorescence as multibranched panicles with cymose terminals (monochasia): flowers pentamerous, calyx quincuncial with heterodromy; corolla convolute in prefloration; androecium of 5-10 or many stamens; gynoecium of 3 carpels, ovary 3-locular with axile placentation and 2 ovules in each loculus, but 1 seed only sets in the normally indehiscent fruit. Cotyledons massive, storing fat, and remaining in the seed at germination. The characteristic new feature is the manner in which 2, 3, or 5 sepals, are extended to laminae which are utilized for spinning the fruits.

**Shorea robusta**, Sal, gregarious, dominant and characteristic of Central India and NE. in deciduous forest, on two sides of Gangetic plain; to 120 ft.; the Dipterocarp farthest north, flowering *en masse* when partially leafless, March.

*Inflorescence* as terminal and axillary panicles, 6 in.; ultimate monochasia with flowers 'sessile', 15-18 mm. over all: sepals 3 mm., with soft grey hairs; petals convolute, 10 mm., dull orange-yellow with soft pubescence, fugitive: androecium of about 30 free stamens, 3 deep; filaments 3 mm., with broad sheathing base and anthers with awl-like connective-process as a trigger-mechanism, pollen-dusting; no specialized nectary. *Gynoecium* of 3 carpels; ovary sub-globular, 2 mm., style simple, stigma 3-lobed; 2 anatropous ovules in each loculus.

In *Fruit* the 5 sepals increase in size; 1, 2, and 3, much more than the others, to 2-3 in. long, each with 10-15 parallel main veins, as photosynthetic and protective to green fruit, utilized later for dispersal mechanism, by strong winds (June): germination hypogeal and immediate.

Cf. *Representative Species*, essentially similar in flower and fruit, *S. Tumbuggaia* in Cuddapah; *S. Talura* in W. evergreen forests of Kanara; *S. Assamica*, Makai, in Assam; *S. obtusa*, Burma, &c., also sp. in Borneo, Amboina, and Cochin China.

**Hopea odorata**, a fine tree of Burma, 100-120 ft., Thingan; in moist tropical forest, non-gregarious, with shining dark-green drooping leaves. Inflorescence of similar terminal and axillary panicles, ultimate monochasia of small greenish-yellow flowers, 10 mm. diam., much as *Shorea*, but corolla gamopetalous below and shed with androecium in one piece; petals convolute with frilled ends; androecium of 15 stamens (in 3 alternating whorls of 5); connective-process as long as anther (1 mm.); gynoecium of 3 carpels, 2 ovules in each loc., one seed sets. Fruit a small nut, 8 mm., with sepals 1, 2, only free and extended to broad wings, 2 in. long, and very characteristic.

**Parashorea stellata**, evergreen tree, 150 ft., of Martaban and the Malay Peninsula. Flowers small cream-coloured; sepals and petals velvety; stamens 15; all 5 sepals equally extended as 'wings' of fruit, 2-3 in. long, the nut velvety and exposed between their bases.

**Pentacme suavis**, a large more deciduous tree, gregarious in Upper Burma, with showy panicles of yellow flowers,  $\frac{3}{4}$  in. over-all, balloon-shaped; stamens 15, connective and 4 anther-tips equally prolonged as 5 awl-like processes. All the sepals enlarge in fruit, but 1, 2, and 3, are larger, 3 in.; the fruit, 20 mm., being exposed between their bases.

**Dipterocarpus tuberculatus**, In (Eng), large gregarious tree, dominant and characteristic of Burmese Indaing-forest on laterite; coriaceous foliage-leaves to 18 in. long and 14 broad, deciduous in hot season. *Inflorescence* of a few (4-7) flowers in axillary clusters towards ends of branches, as reduced cymose systems. Flowers dull-purple, 2 in. across, with contrasting grey tomentose calyx: receptacle slightly crateriform. *Calyx* a massive gamosepalous tube, 10 mm., closely investing the essential organs, with slight commissural ridges. Free segments quincuncial, and 1, 2, to 15-20 mm., the others half as long. Corolla markedly convolute (L in R-hand flower). *Androecium* of 30 (15 + 10 + 5) stamens, symmetrically spaced; connective-extension 2 mm. *Gynoecium* of 3 carpels; upper part of ovary massive, style straight, with 3 minute stigma-lobes. Trigger-mechanism and no obvious nectary.

In *fruit* the style is broken away leaving a stout pointed nut, 20 mm., 1-seeded, with large folded cot., and enclosed in massive woody calyx-tube, 1-1 $\frac{1}{2}$  in. diam.; the wings of seps. 1 and 2 are 6-7 in. long and 1 in. broad, 3-veined; sepals 3, 4, 5, small and reflexed. The commissural ridges are enlarged and 'tubercled' above. The spinning-mechanism depresses the 'wings' on a 10-inch circle. Germination hypogeal and immediate. An advanced xeromorphic type. Other forms characteristic of moist, more evergreen tropical forest are:

**D. turbinatus**, Kanyin, a tall tree (150 ft.) of mixed forest in Burma, very similar, but lacks the tubercled commissural ridges, the wings smaller, 5 in. In *D. costatus* and *D. alatus* the ridges are greatly exaggerated, and there is much variation in details of fruit. For representative species cf. *D. zeylanicus* of Ceylon, *D. indicus* of W. Ghats, *D. Bourdillonii* of Travancore 150 ft. and 5 ft. diam., *D. pilosus* in damp evergreen forest Assam, with wings 7-9 in., *D. Dyeri*, Cochin China.

Cf. also **Vatica Roxburghiana**, of evergreen forest of S. Kanara and Ceylon; fruit subglobose, 1-1 $\frac{1}{2}$  in. diam., woody and hairy, retaining 3 coriaceous sepals, but not 'winged'.

**Vateria indica**, evergreen forests of W. Ghats, and cult.; with gum-resin (Piny Varnish): In fruit (2-2 $\frac{1}{2}$  in.) the sepals are reflexed and dehiscence is by 3 valves. Seeds large and storing fat (Piny Tallow); stamens 40-50; possibly the most generalized of the family.

**MALVALES** include a large section with general Cistifloral characters combined with minor points of higher-grade specialization, remarkably constant, which may be checked with comparative facility, hence affording convenient clues to classification: cf. 'valvate' sepals, a 'column' type of androecium, nectary-glands on sepals, and often 'monothecic' anthers (two-locular). Three great alliances have been given family status:—

I. The Malvaceae as the key group, with elaborated floral mechanism, including the full set of characters previously mentioned.

II. The Tiliaceae, a tree family, in which the flowers present simple reduction variants, which may approximate the more generalized Cistifloral stock.

III. The Sterculiaceae, in which the widest range obtains from high-grade pollination mechanisms to most reduced (fly-pollinated) limiting expressions.

In N. Temp. regions the series has been approached from the standpoint of *Malva* and *Tilia* of N. Europe. In the Tropics all 3 families attain considerable importance, not only in floral organization, but as giving fine timber-trees of forest-formation, as well as economic products, textiles, fruit.

I. **Malvaceae** (33/900), typically with pentamerous petaloid flowers, actinomorphic, with 'epicalyx' of bracteoles, convolute corolla, column-like androecium, connected with the corolla and shed in one piece, as the complex prolongation of a festooned androecial tract, with monothecic 'anthers' producing large spinous pollen-grains. Carpels in one cycle; few, large and multiovulate, or many with 1 ovule each. Fruit a capsule, dehiscent, or no longer so, or as indehiscent 1-seeded 'cocci', separated from the floral receptacle.

Cf. *Althaea rosea*, Hollyhock, herbaceous perennial, for fine flowers, 3-4 in. diam.; epicalyx 6-lobed, anthers 240-400, monothecic, in antipetalous crests of double pairs, on a column 20 mm. high; carpels 40-50, each 1 ovule: fruit separating dry flat cocci, 8 mm. *Malva sylvestris*, reduced indig. form, anthers to 80, carpels to 15.

**Gossypium herbaceum**, Cotton-plant of Old World. Cult. in annual rotation. Leaves palmate, flowers yellow with purple spot at base, continued in leafy lateral monochasia; epicalyx of 3 lacinate segments; typical column-androecium with clustered anthers; carpels 3, ovary syncarpous with many ovules in each loc.; style with 3 stigmatic branches. Mechanism protandrous. Fruit a small capsule (20 mm.) dehiscing by 3 valves; seeds packed with hairs (cotton) of testa: endosperm with fatty oil, small embryo; cf. *G. arboreum*, Trop. Africa, a woody shrub: *G. barbadense*, Trop. Amer., seeds with 'long-staple' hairs. *Hibiscus* sp. cult., epicalyx of numerous segments.

**Thespesia populnea**; evergreen tree of littoral forest in Tropics, also planted; foliage like Poplar, flowers like *Gossypium*, but epicalyx reduced; carpels 5, stigmas fused in club-shaped mass. Capsule with silky seeds.

II. **Bombaceae** (20/140), often separated from Malvaceae by lack of some characters (no spinous pollen), and greater range in others (column-system more complex), seeds with little endosperm but large embryos.

**Bombax malabaricum**, Simal, Silk-Cotton Tree, Huge tree of alluvial ground, to 130 ft., buttressed trunk, soft wood, conical stem-prickles, large digitately 5-7 lobed leaves, deciduous in hot season. Flowers (Feb.) before the leaves, large, scarlet, massive, gaudy, bee- and bird-pollinated, 4-6 in. Calyx leathery, splitting irregularly, with nectary-hairs of type. Androecium in 5 outer bundles of a dozen or more stout filaments 55 mm., with twisted monothecic anthers, a few intermediate single filaments, and 5 inner (antisep.) branches each 2-fid with 2 anthers only: no definite 'column'. Gynoecium 5-locular, with numerous ovules, style 5-lobed. Fruit a large capsule, 5-6 in.; seeds packed in dense mass of brownish silky hairs growing from the lining of the wall. Cotyledons much folded.

Cf. *B. insigne*, a large deciduous tree of S. India and Burma: flowers 9 in. diam., similarly on old wood; petals scarlet, 5-6 in.; stamens 400-600, with no definite column, 5 in.; fruit capsule 4-8 in.

**Eriodendron anfractuosum** (*Ceiba pentandra*); Large deciduous tree of Trop. Amer. and Malay, planted in India and Burma: stems with prickles, leaves digitate: flowers cream-white; androecium in 5 segments, simulating stamens, each with 4 twisted anthers; Gynoecium of 5 carpels; capsule, 3-5 in., packed with white silky hairs (Kapok).

**Adansonia digitata**, Baobab of Trop. Africa, cult., to 75 ft. and 20-30 ft. diam.; trunk massive, water-storing, often hollow, to 1000 yrs. old, enormous tap-root (100 ft. or more). Flowers large, white 6 in., with massive staminal column and crown of stamens. Fruits large (8-12 in.) pendulous, indehiscent, with large seeds in acid pulp, with woody fibres, eaten by natives and animals. Seeds 15 mm., embryo large and much crumpled, endosperm reduced to a thin film.

**Durio zibethinus**, Doorian, Malay and cult. in S.; large fruits, to 12 in. long, with soft prickles, indehiscent, offensive smell; seeds with succulent arils as edible pulp.

**Cullenia excelsa**, a large tree of W. Ghats in damp forest, young shoots and calyx with peltate scales. Flowers reddish-brown, *apetalous*, androecium in 5 filiform segments, each with about 10 pairs of anther-clusters in longitudinal series; fruit, 3-4 in. diam., 5-locular, densely spinous, each loculus with 1 large seed with a fleshy white aril. Cotyledons massive.

III. **Sterculiaceae**, (48/660) centred on *Sterculia foetida* of tropical coast-forest: an empirical range of types distinguished from preceding by the normal dithecic (4-loc.) anthers, the column rudimentary, decadent, or with alternative gynandrophore region. The valvate calyx persists, the stamens are few, the gynoecium fully syncarpous, or with the carpels united only in a common style-shaft, and breaking away in fruit to simulate apocarpous follicles. Extreme types may be apetalous and diclinous: the majority are fly-pollinated (accounting for the odour).

**Pterospermum acerifolium**, a tall evergreen tree of hill-forest, and planted: flowers large, scented; sepals hairy, petals white, 5-6 in., all recurved (moth-pollinated): no column, but a gynandrophore-internode (20 mm.), a group of 3 stamens opposite each petal, and 5 long antisept. staminodes (3 in.) and style-shaft; 5 carpels, antipet., 5 locular. Fruit a particularly massive woody capsule (2-6 in.), ripening the second season, dehiscing loculicidally, wall woody,  $\frac{1}{2}$  in. thick; seeds numerous, with broad spinning-wing 30 mm. long.

**Theobroma Cacao**, a small tree of S. Amer. (Cocoa), cult.; flowering spurs on old wood: flowers small and insignificant, 15 mm. over all, 5-parted; column rudimentary, 5 dithecic stamens with anthers sheltered in hooded tips of petals, alternating with 5 slender pointed 'staminodes'. Fruit a large indehiscent capsule (8-9 in.), with many large irregular seeds: endosperm scanty, large cotyledons (cocoa-nibs) store fat.

**Sterculia urens**, a large tree of dry deciduous forest with conspicuous silvery bark. Flowers in crowded panicles with tomentum of glandular hairs, *apetalous*; Staminate flower with 20 stamens on a short internode. Hermaphrodite flowers (few) with short gynandrophore and 4-5 carpels fused in style-shaft only. Fruit of ovoid radiating follicular segments, 3 in., red internally, with 'stinging' bristles: seeds 3-6 per pod.

**S. villosa**, a common tree in dry deciduous forest; flowers yellow in clustered drooping panicles on leafless branches: majority of flowers staminate only: calyx campanulate, hairy; anthers 10, on short internode. Follicular segments 2-5, coriaceous 3 in., red, with stiff hairs and several blue-black seeds (like *Paeonia* pods).

**S. (= *Pterygota*) alata**, a very large tree of moist evergreen forest: planted: calyx rusty-tomentose, gamosep. and campanulate: stamens 15, on long internode.



Follicular segments, 1-5, huge subglobose pods, 4 in., stalked 3-4 in., seeds in 2 rows, large and winged, 2½ in.

**S. (= *Firmiana*) colorata**, a large soft-wooded tree of Sub-Himalya, E., and S. India; bright-red inflorescences of flowers with stellate tomentum: calyx 1 in. long, funnel-shaped, with 5 teeth: gynandrophore long and projecting: stamens small, carpels 5. In fruit the follicular segments become membranous, leafy, coloured pink, and break away with each 2 marginal seeds (in simulation of theoretical carpel).

**S. foetida**, a deciduous tree with digitate leaves, flowers on bare branches, very offensive; follicular segments as woody pods, bright-red, many-seeded.

**Heritiera littoralis**, widely distributed in tropical sea-coast forest, gregarious and evergreen: panicles of small flowers, apetalous, mostly staminate only, and much reduced. Leaves coriaceous, silvery underneath. Fruits as stout, strongly keeled, 1-seeded nuts, exalbuminous.

**H. Fomes**, Sundri, gregarious evergreen tree characteristic of Sundribans, on alluvium behind Mangrove zone: roots with 'tent-peg' pneumatophores: calyx 4-5 toothed; staminate flower with rudiment of gynoecium shows the limit of reduction: stamens 4-5: gynoecium of 5 carpels, separating as woody nuts, slightly keeled, floating at the highest tide-levels.

Cf. **H. macrophylla**, a large tree of Burma, inland, fruits globose with a 'beak' -portion and no keel. **H. Papilio** of W. Ghats in evergreen forest, carpels with a broad membranous wing, strongly veined.

**IV. Tiliaceae (35/350)**. Forest-trees with flowers of mediocre Cistifloral habit, but little special modification—sepals valvate, anthers dithecic, no column—but stamens often in 'bundles', ovary syncarpous. Fruit tending to indehiscent nut or drupe. Cf. *Tilia*, indig., and *Sparmannia*, Hort.

**Corchorus capsularis**. Jute (with *C. olitorius*), herbaceous annual, indig. to China, cult. Bengal and Assam, valuable fibre (Gunny); 8-12 ft., Flowers 1-3, opposite the leaves, small, yellow, 12 mm. diam., pentamerous; stamens many, on a short column; Fruit a sub-globose, longitudinally-ridged capsule, many-seeded; elongated and beaked in *C. olitorius*.

**Pentace burmanica**, Thitka, large evergreen tree of Hill-forest, Burma; Stamens in 5 bundles of 4-7 each, alternating with slender staminodes. Capsule over 1 in. long, indehiscent, with 5 broad longitudinal wings, 1-seeded.

**Berrya Ammonilla**, a tall deciduous tree of Burma, &c.; Flowers white, ½ in., with numerous stamens, no staminodes, ovary 3-4 locular. Fruit a small capsule with several seeds and 3 pairs of horizontally extending wing-segments, 1 in. long.

**Grewia oppositifolia**, a common deciduous tree of W. Himalya, planted; stamens indefinite on a slight internode, Fruit a drupe, deeply 2-4 lobed with same number of pyrenae, black when ripe; a large genus, 30 sp. Indian.

**Elaeocarpus Ganitrus**, typical of a large genus (123, Indian 26) of evergreen trees of moist tropical forest, flowers small with fringed petals: stamens 25-35. ovary 5-locular: Fruit a globose drupe, 1 in. diam. with characteristic solid sclerocarp, grooved and corrugated, commonly 1-seeded. **E. lanceafolius**, a large tree common at Darjeeling.

**DISCIFLORAE** (*Gen., Plant.* 1862), a convenient assemblage of largely tree-phyta, characterized by a *eucyclic* type of floral organization, in which reduction of the androecium to a limit of 5+5 in whorled alternation is typically associated with the specialization of a receptacular *disc*-nectary, usually indicating entomophily by the agency of insects with short-probosces (primarily).

The floral organization thus normally presents a quincuncial calyx, a whorled pentamerous corolla, two whorls of stamens, and a single whorl of 5 carpels: the alternation is not necessarily concurrent throughout the system, and the 5 carpels are typically antipetalous. The gynoecium may reduce to fewer carpels (4, 3, 2), rarely increased by irregularity, and the output of ovules may vary within wide limits. The eucyclic type appears as the symmetrical and complete construction formerly abstracted empirically by older morphologists as a key to floral evolution.

The construction may present further *specialization* for insects of higher grade, as by zygomorphy (median or oblique), or by attempts at tubular organization in calyx or androecium. *Reduction* may occur in phases of tetramery, irregularity in hexamery, declivity and dioecism, apetaly, isostemony, and the limitation of gynoecial output, with a single ovule setting a single seed per flower as the end-term. All phases of fruit-elaboration obtain, from many-seeded dehiscent capsules to indehiscent berries, nuts, and drupes. The families have been sorted out largely by special features of somatic organization and by special types of fruit-elaboration.

In absence of any other very distinctive characters it has become traditional to isolate two empirical series, according to the orientation of the residual ovules in the reduced ovary, as Geraniales (*Geranium*-type), ovules pendulous with raphe internal, and Sapindales (*Horse-Chestnut*-type), with raphe external. More herbaceous families (*Oxalidaceae*, *Linaceae*, *Geraniaceae*, *Tropaeolaceae*, *Balsaminaceae*) in cultivation (*Hort.*) are omitted, and the declivous *Euphorbiaceae* are taken in their old position with the apetalous families as a matter of convenience (p. 36).

Also *note*, the characteristic disc-nectary (*discus*) may be intra-staminal, extra-staminal, generally receptacular, or superseded by other mechanism (*Pelargonium*, *Tropaeolum*, *Impatiens*), and there is no very convincing evidence that many of the families conventionally associated express any actual derivation from the typical eucyclic construction after all (*Aesculus*, *Acer*, *Tropaeolum*), but may represent end-terms of a general convergence to a minimum of working-mechanism of similar parts.

**I. Erythroxylaceae** (2/194) isolated for *Erythroxylon*; cf. *E. coca* of S. Amer. *Erythroxylon monogynum* a small tree of dry districts, S. India; leaves, 1 in., simple; flowers small, 6 mm., axillary; pentamerous with 5+5 stamens united below in a staminal tube, and 3 carpels: Fruit a scarlet drupe, 1 loculus fertile with 1 seed.

**II. Malpighiaceae** (54/500) woody shrubs, largely lianoid, based on *Malpighia* of Tropical America: flowers pentamerous, commonly zygomorphic, stamens 5+5, carpels 3.

**Hiptage Madablota**, a straggling climbing shrub of forest-ravines: flowers complex, with sternotribal presentation, obliquely zygomorphic in plane of sep. 3 (giving odd petal at back), 1 in. diam.; stamens 10, the front one larger than the others; carpels 3: Fruit an angular nut, 1-seeded, with 3 divergent wings, the middle one longer, 2 in.

**III. Rutaceae** (111/800) a key-group (cf. *Ruta*) with typically full eucyclic organization, distinguished by oil-glands in the leaves: flowers range to tetramery, with irregularities of construction in Aurantiaceae-section: cf.—

**Choisya ternata** (*Hort.*), evergreen shrub of Mts. of Mexico, leaves opposite, 3-lobed, glossy and aromatic: terminal corymbose panicles of white flowers, 1 in. diam.; petals 5-8, stamens 10-15; the filaments massive, white, making close-

contact around the ovary, restricting lateral access to the intrastaminal disc (tending to tube-protection of secretion).

**Citrus medica**, a hill-shrub, cultivated in vars. as Citron, Lemon, Limes; stamens 25-55, in single palisade of strap-shaped groups; carpels 9-11; flowering and fruiting throughout the year.

*C. Aurantium*, Orange, of E. Himalya, cult. in vars., stamens 15-30, carpels 10-13, often a reduced second whorl: moth-pollinated.

*C. decumana*, Grape-fruit, Shaddock; flowers larger, petals recurved; stamens about 40, in tubular palisade, 10 mm.; carpels 8-16: fruit to 8 in. diam. and 5-6 lb.

**Aegle Marmelos**, Bael-tree, a small tree of dry deciduous forest, 40 ft., with spinous branches, much cult. Flowers greenish-white, 1 in. diam., fragrant. Stamens indef., carpels 10; Fruit an Orange-type, 4-5 in. diam., with yellow hard woody rind, and numerous seeds in orange-coloured sweet aromatic pulp: taken by animals, monkeys, deer, &c.

**IV. Simarubaceae** (27/125) based on *Simaruba* a medicinal plant of W. Indies, for Discifloral forms in which the carpels are united in the style-shaft, but break away in the fruit-stage, and so appear 'apocarpous'. No oil-ducts or glands; the flowers more or less reduced and declinous.

**Ailanthus excelsa**, a large tree of deciduous forest, also cult., leaves pinnate (12 pairs), 1-3 ft. Staminate flower with 10 stamens only: carpellary flower of 5 carpels, maturing fruit as 1-5 flat red samaras, 2½ in.; seed centred and a slight spiral twist at the ends.

Cf. *A. glandulosa*, China, cult., dioecious; samaras 2 in., red when mature; leaflets with glandular teeth near the base: spreading by root-suckers.

**V. Burseraceae** (16/320), based on American forms of *Bursera* for a group of tropical trees with resin-ducts: flowers small and of considerable range: cf. *Balsamodendron Myrrha* of Arabia, &c.

**Boswellia serrata**, Salai, a fairly large deciduous tree, common and gregarious on dry hills, leafless in hot season: Flowers small, 5 mm., green, on the bare branches: stamens 5+5, disc intrastaminal: ovary 3-locular, fruit dehiscent by 3-valved sarcocarp, with 3 pyrenae.

**Garuga pinnata**, a large deciduous tree, associated with Sal and Teak; flowers comparatively large, in yellowish panicles, with marked perigynous cup: stamens 5+5, ovary 4-6 locular, each 2 ovules: Fruit a drupe with 2-4 tubercled pyrenae persisting in soil 1-2 years.

**VI. Meliaceae** (40/600), a great order of tropical forest-trees, with paniced inflorescences of small Discifloral flowers, normally distinguished by the characteristic utilization of a staminal tube, as practically a gamophyllous mechanism protecting the gynoeceum and ultimately also controlling the nectary: petals tend to become superfluous. Fruits characteristically capsular, with winged seeds, but commonly ranging to drupes with reduced output of seeds: in one important genus at least there is no staminal tube.

**Swietenia Mahagoni**, Spanish Mahogany, a great tree of Trop. Amer., leaves pinnate, panicles of small flowers, 7 mm.; staminal tube, 3 mm., urceolate, with 10 teeth alternating with the anthers. Fruit a woody capsule, 3 in., 5-valved, with numerous winged seeds. Cf. larger fruit of *S. macrophylla*, 5-6 in., falling to pieces, seeds winged, 3 in.

**Walsura villosa**, Gyobo, common evergreen tree of Burma: flowers, small, 5 mm., with filaments gamophyllous below, broad and convergent above, seed with fleshy aril in a pointed berry. *W. robusta*, similar, filaments free.

**Azadirachta indica**, Neem, cult. everywhere, monotypic; leaves pinnate, evergreen; flowers in large panicles, small, white, 10 mm. diam.; staminal tube, 5 mm., narrow, with 10 teeth superposed to 10 anthers: disc inside the tube; carpels 3, each 2 ovules; Fruit a drupe, ¾ in., 1-seeded.

**Melia Azedarach**, 'Persian Lilac', a deciduous tree in general cult. Leaves 2-3 times pinnate. Flowers 12 mm. diam.; petals white, staminal tube, 6 mm., narrow, violet-purple; anthers 10, alternating with paired tooth-processes of tube; Gynoecium 3-6 locular, 2 ovules in each loc.; Fruit a small drupe with 5-seeded bony sclerocarp, giving 1-4 seedlings.

**Carapa moluccensis** (= *Xylocarpus*), a timber-tree of the Sundribans and Mangrove-formation, 30-50 ft., with pneumatophores; evergreen, leaves pinnate, panicles of few small reduced flowers, tetramerous, with urceolate staminal tube and 8 teeth alternating with the anthers. Ovary 4-loc., 2-8 ovules in each loc.; fruit 3-5 in. diam., as a massive subspherical woody capsule, dehiscing by 4 valves, and shedding large angular seeds (1-2 in.), which float or germinate immediately; cotyledons store starch, germination hypogeal.

**Soymida febrifuga**, a large deciduous tree of dry forest of S. India, &c.; leaves pinnate; flowers small, greenish-white in terminal panicles; staminal tube 10-cleft, with 2 teeth on either side of the anthers. Ovary 5-locular; fruit a capsule, 1-2 in., dehiscing by 5 woody valves: seeds flat, winged at both ends.

**Chukrasia tabularis**, a large tree of moist hill-forest (Chittagong); flowers white,  $\frac{1}{2}$  in. long; staminal tube cylindrical with 10 anthers on the rim. Ovary 3-locular; fruit a capsule,  $1\frac{1}{2}$  in., dehiscing by 3 woody valves; seeds broadly winged at one end.

**Cedrela Toona** (= *Toona ciliata*) Toon-tree, a large deciduous tree of Sub-Himalya and moist hill-forest, cult.; Flowers small, white, in loosely paniced systems; there is no true staminal tube, but a receptacular extension as nectary-pockets at the base of the flower (antisept.), between orange lobes of the 'disc': stamens 5 only (antisept.). Fruit a typical 5-valved capsule with many close-packed seeds,  $\frac{1}{2}$  in. long, winged at both ends and spinning freely. Cf. *C. serrata*, with 5 stamens and 5 staminodes: *C. odorata* of W. Indies, seeds winged at distal end only.

**Chloroxylon Swietenia**, Satinwood; valuable timber-tree of Central and S. India, distinguished from the preceding by absence of staminal tube, and with gland-dotted leaves. Disc 10-lobed, intrastaminal; ovary 3-locular; Fruit a typical capsule dehiscing loculicidally by 3 valves as in *Chukrasia*, with winged seeds. With pinnate foliage, small flowers in panicles, generalized eucyclic flower and capsular fruit with winged seeds common to many Meliaceae, but now referred to Rutaceae.

**SAPINDALES** (Engler) include families of tree-habit, in which the full eucyclic floral construction is rarely expressed. Reduction-variants of all grades occur, and may have had a wholly distinct origin. The fruits range from dehiscent capsules to indehiscent nuts and fleshy drupes: in one family the limit of gynoeceal reduction to one ovule per ovary, setting a 1-seeded drupe or nut, is constant. The Rhamnales, a section of minor significance, with the androeceum reduced to isostemony, and the stamens superposed to the petals, is added as a matter of convenience.

**Aesculus indica**, a fine Horse-chestnut of NW. Himalya, very similar to the common form, affords a typical case: a large deciduous tree (100 ft.), in moist shady ravines, with decussate digitate foliage-leaves and terminal pyramidal panicles (12-15 in.) of white zygomorphic flowers (petals with yellow splash turning crimson), in lateral monochasia; zygomorphy oblique in plane of sep. 4; corolla of 4 petals, androeceum of 7 stamens, and ovary of 3 carpels. Fruit a dehiscent massive capsule (2 in.), without spines; seeds 1-2 in., with massive cotyledons storing starch. On the strength of the peculiar androeceum and the decussate digitate leaves, the type is often separated as Hippocastanaceae (including *Pavia*).

**Sapindaceae** (118/1050), a large and characteristic order of tropical trees, more generalized than *Aesculus*, leaves commonly spirally arranged, pinnate or simple, but also of wide range in floral reduction (following declivity and apetal). The fruits range from dehiscent capsules to individualized drupes; the 3-carpelled gynoeceum is a general feature, and the stamens are commonly 8 (or less than 10). Genera have been grouped around *Sapindus*; cf. *S. Saponaria* of S. America, as yielding 'Soap Nuts' of economic significance: cf. as typical:—

**Xanthoceras sorbifolia**, China (Hort.), with deciduous pinnate foliage, spirally arranged: flowers in erect terminal systems, declinuous; petals white (with yellow turning pink); staminate flower with 8 functional stamens; disc prominent with 5 orange-yellow horn-like nectary-lobes: carpellary flower with 3 carpels, syncarpous, and several ovules: fruit a large woody capsule, dehiscent loculicidally.

**Sapindus laurifolius**, Soap Nut of S. India, a large evergreen tree of dry regions, much planted: leaves pinnate, 3 pairs of large leaflets. Flowers staminate, with a few perfect: sepals 5, petals 4-5, stamens 8, ovary 3-lobed. In fruit the ovary lobes separate as 2-3 small indehiscent drupe-portions, readily detached: the seeds contain saponins.

**S. detergens** (= *Mukorossi*), with 5-10 pairs of leaflets, is the representative species in NW. Himalya, cult. for soap: Drupes usually solitary (1-2), the others rudimentary,  $\frac{3}{4}$  in.

**Nephelium Litchi**, evergreen tree of S. China, cult. for fruit; Flowers in large panicles, few, hermaphrodite, small, apetalous, and irregular in construction: calyx 4-8 cleft, gamosepalous; petals usually wanting; stamens 5-10, ovary 2-3 lobed, each loculus with 1 ovule. In fruit (edible) 1 or more lobes enlarge to sharply tubercled globose structures (1 in. diam.) with 1 seed enclosed in a white pulpy aril.

**N. Longana**, a timber-tree of W. Ghats and Ceylon, essentially similar, but fruit  $\frac{3}{4}$  in., nearly smooth, also with sweet edible aril.

**Dodonaea viscosa**, a small tree (20 ft.), gregarious as scrub in dry tracts of Central India, &c.; young branches exude yellow resin: flowers paniced, small, 5 mm., greenish-yellow, apetalous, with 8-10 large anthers; ovary 3-4 locular, 2 ovules in each loculus. The fruit is a thin-walled capsule, 2-4 valved,  $\frac{3}{4}$  in. over all, each valve with a broad wing-extension.

**Scleichera trijuga**, a large tree of mixed dry deciduous forest, often gregarious, the best for Lac-insect. Leaves conspicuously of 3 pairs of leaflets. Flowers in drooping panicles (3-5 in.), largely staminate only and apetalous, or

partially dioecious, 5 mm. Calyx minute with 5-6 teeth, petals wanting; stamens 6-8, divergent; disc with wavy lobes; ovary with 3-4 loculi, basal placentation, and 1 ovule per loculus. Fruit globose, 1 in. long, 1-2 seeded, indehiscent: seed with pulpy (edible) aril, storing oil.

As examples of smaller families, based on tree-forms familiar in the N. Temp. forests, and presenting representative species, cf.—

**Ilex dipyrrena** (Aquifoliaceae), a type very similar to *Ilex Aquifolium*, in valleys of NW. Himalya; flowers greenish-white, declinuous, tetramerous, but usually 2 carpels only, ovules 1 per loculus, pendulous with raphe external, hence fruit usually with 2 pyrenae.

**Euonymus Hamiltonianus** (Celastraceae), also a typical *Euonymus*, as a small tree of outer Himalya: tetramerous type of construction, flowers 8 mm. diam.: disc broad over centre of flower. Fruit deeply 4-lobed, and seeds with crimson arils.

**Acer pictum** (= *cultratum*) (Aceraceae), a typical Maple of NW. Himalya; a large deciduous tree, with palmate very acutely lobed leaves and early-flowering corymbose panicles. In fruit the 2 carpel-wings diverge widely in the same line, and turn bright red.

Cf. *A. caesium*, a large deciduous tree of W. Himalya; fruit-wings only slightly divergent; also as representative species, *A. Campbelli* of E. Himalya, flowers in narrow panicles, and carpel-wings diverging 1 in. with broad rounded ends.

**Anacardiaceae** (58/500), based on *Anacardium* with its peculiar fruit. A great group of important tropical trees (cf. *Rhus* of N. Temp.) segregated by the limiting reduction of the gynoeceum of 5-3 carpels to output of one usually pendulous ovule only. The flowers are of typical small Discifloral habit, greenish-white, panicked, fly-pollinated; the stamens 10-5 (or reduced), and the carpels practically free, or traced only in the stigma-lobes. The seeds are exalbuminous and the cotyledons store fatty oil. Acrid juice, lacquer, and resin are characteristic products.

**Anacardium occidentale** of S. Amer., cult. (Cashew Nut): Panicles of small yellow-pink flowers; petals linear, stamens 10, the one over sepal no. 1 longer and fertile, the others reduced and sterile. Fruit a kidney-shaped drupe (1 in.) on an orange or crimson enlarged receptacle ('hypocarp'), 2-3 in., edible, and dispersed by birds. Pericarp with acrid blistering oil.

**Semecarpus Anacardium**, Marking Nut: panicles of small flowers; drupe, 1 in., purple-black with orange hypocarp (edible): pericarp with acrid juice.

**Mangifera indica**, Mango, indig. to Burma and moist hill-forest, cult. in vars. and grafted: panicles of greenish-white flowers, 5 mm.; majority staminate, few hermaphrodite, with only 1 fertile stamen, and 4 others reduced and sterile. Drupe 2-6 in., yellow, with one great seed in fibrous sclerocarp; cotyledons with fat-storage, germination hypogeal.

**Buchanania latifolia**, conspicuous small tree, 50 ft., of deciduous forest with Sal, and in Burma: characteristic faceted bark: flowers in tomentose panicles, small, 5 mm., greenish-white; stamens 10, carpels 5, one fertile and others as rudiments. Fruit a drupe,  $\frac{1}{2}$  in., edible, with bony sclerocarp.

**Spondias mangifera**, a large tree of deciduous forest, and planted; fruit large in manner of Mango, edible and taken by deer.

**Melanorrhoea usitata**, characteristic large deciduous tree of Eng forest (Black lacquer): in fruit the petals grow to 5 'wings', 2-4 in. long, pink when growing and suggesting flowers, spinning freely. Fruit a dry nut on a distinct 'stalk' internode.

**Swintonia floribunda**, conspicuous tree in hill-forest (Chittagong), of similar habit in fruit; Nut elongated, not 'stalked', with 5 petal spinning-wings, purple, ultimately 2 in. long.

**Odina Wodier**, a large spreading tree of deciduous forest of India (with Sal) and Burma, cult.; Flowers in feathery whitish panicles, small, monoecious; carpellary flowers with sterile stamens. Drupe  $\frac{1}{2}$  in., taken by birds.



**Pistachia integerrima**, deciduous tree of dry slopes of W. Himalya, with characteristic leaf-galls 6-7 in. long. Flowers small, dioecious; Drupe  $\frac{1}{4}$  in.

**Rhamnaceae** (45/500) based on European *Rhamnus* (Buckthorn); cf.—

**Zizyphus Jujuba**, a spinous tree, largely cult. for fruit: flowers small, greenish-yellow; ovary sunk in receptacle, 2-locular; fruit a drupe,  $\frac{3}{4}$  in. long (to  $1\frac{1}{2}$  in. cult.), with furrowed stone, 2-seeded and giving 2 seedlings.

**Ampelideae** (Vitaceae, 11/450) include liana-forms as *Vitis*, Wild Vines, 400 sp., cf.:—

**Vitis vinifera** indig. to NW. Himalya and W. Asia, cult.; a large woody climber with inflorescence-tendrils: flowers small, green, paniced, petals cohering distally and shed; stamens 5 antipet., free: carpels 2, ovules 2 (3) per loculus: berry 3-5 seeded, endosperm solid with thick walls.

**Leea**, a genus of erect shrubs, no tendrils, flowers with greater range, stamens uniting with petal-bases in a staminal tube. *L. umbraculifera* in valleys, Sikkim, 50 ft., with thick trunk.

The **LEGUMINOSAE** (429/12000) commonly approached through the herbaceous types of Bean and Pea of N. Temp. cultivation, represent a vast series of polypetalous apocarpous phyla, in which the gynoeceium is restricted to the limit of one carpel only, of very typical megasporophyll nature, giving rise normally to a 'pod'-fruit or legume. With this reservation the floral mechanism, based on a limiting expression of pentamerous eucyclic construction, may be further complicated in terms of the zygomorphy more familiar in the Papilionaceous type, but may also present extended range of specialization and reduction in the more distinctly tropical series of the Caesalpineae. On the other hand, the section Mimoseae presents a similar gynoeceial reduction in a phylum of very divergent nature; the three sections being in fact sufficiently distinct to be regarded as independent families, convergent in this limiting reduction of an archaic apocarpous phase, and still holding their own in competition with syncarpous types, as in practice a single ovary-construction per flower has been attained.

**I. The Papilionaceae** (308 gen.), following the general type of the Pea and Bean in floral organization, include many fine forest-trees; generic types may be isolated by special features of the fruiting-stage, and the characters of the foliage-leaves.

**Butea frondosa**, Dhak, a deciduous tree of open grass-lands, flowering *en masse* on the bare stems. Leaves trifoliate, leaflets coriaceous, 4-6 in. broad: Flowers orange-red or scarlet, 2 in.; standard recurved, keel boldly arched, stamens 9+1; pod 5 in. (4-8), flat, with one flat seed at base, and the distal part acting as spinning-wing, 4 in.

*B. superba* a gigantic liana-form of S. India; stem to 8 in. diam., flowers larger, bright orange.

**Dalbergia Sissoo**, Shisham; a large deciduous tree of Sub-Himalya, &c., often gregarious on alluvial ground, much planted; Flowers small, 7 mm., yellowish white, in short axillary panicles. Stamens 9, pod linear lanceolate, 2-2½ in., 1-3 seeded, light, flat, indehiscent, wind-distributed and floating on flood-water.

Cf. *D. latifolia*, Rosewood, a large tree of deciduous forests: Larger pinnate leaves, inflorescences, and pods, of same type.

*D. Melanoxylon* of W. Africa, naturalized: *D. Olivieri* in Eng forest.

**Pterocarpus**, also a valuable timber genus, with representative species, distinguished by broadly winged, one-seeded indehiscent fruits:—

*P. indicus*, Burmese sea-shore Padauk; pod flat and nearly circular, 1-2 in. diam.;

*P. dalbergioides*, Andaman Red Wood, evergreen.

*P. macrocarpus*, deciduous, Inland Padauk of Eng Forest; pods 2½-3 in. diam.;

*P. santalinus*, Red Sanders, of Cuddapah, pods 1½ in.:

**P. Marsupium**, Bija Sal, a large tree (100 ft.) of deciduous forest: Kino. Flowers, yellow, 18 mm., stamens 10, tube slit down in med. plane; Pods 1½-2 in., 1-2 seeded.

**Pongamia glabra** of tidal coast-forest: flowers typical, Pea-like, 20 mm.; post. stamen free at base only: pod xerophytic, massive leathery, 2 in. long, and 1 broad, 1-2 seeded, germination hypogeal.

Cf. also:—*Sophora japonica* (Hort.) with 10 stamens, all free: *Colutea* (Hort.) with bladder-pods: *Indigofera tinctoria*, Indigo, flowers small, in purple racemes; stamens 9+1, pod simple; a shrub often cult. as annual: *Mucuna*, pods 2-3 in., with irritant bristles: *Desmodium gyrans*, Telegraph Plant, herbaceous trifoliate leaves, 2 lateral small pinnules show automatic movements, end-leaflet nyctitropic only. *Aeschynomene aspera*, Sola, a water-plant, with stem 2-3 in. diam. and soft pith-like white wood. *Ougeinia dalbergioides*, common in Sal forest, and cult.;

flowers in clusters on old twigs, pods slender with slight constriction between the seeds.

**II. Caesalpineae** (91/1100), a series in which the Pea-type of flower is infrequent. Examples of extreme zygomorphy occur, but practical actinomorphy may be retained, or parts may be further reduced; cf. as available:—

**Cercis Siliquastrum**, Judas Tree, of S. Europe: Flowers on bare branches in clusters on spur-shoots before the leaves, pink and Pea-like,  $\frac{3}{4}$  in.; stamens all free; a definite perigynous receptacle as nectary-cup, the standard-petal enclosed within the wings, as these are inside the keel. Pods flat, 3–4 in., hanging from the branches.

**Haematoxylon campechianum**, Logwood; small tree of W. Indies, cult.; Flowers actinomorphic, 8 mm.; petals equal, yellow; stamens 5+5, but one carpel only, and the fruit one-seeded: in some respects possibly the most elementary form of the group.

**Hardwickia binata**, Anjan; a large gregarious timber-tree of dry deciduous forest of S. India, deep-rooted; Leaflets 2 only, 1–2 in. long, with terminal pointed rudiment: Flowers small, greenish-yellow, 15 mm., in lax racemes, *apetalous*; sep. 5, stamens 5+5, one carpel; fruit a flat pod,  $2\frac{1}{2}$  in., indehiscent with one seed at distal end, spinning-type: the limit of simple reduction. As extreme cases, cf.:—

**Cassia Fistula**, a tree of deciduous forest, and commonly cult.; leaves pinnate; with pendulous racemes of yellow flowers (suggesting *Laburnum*): stamens differentiated, 3 long anterior dehiscing by slits, 4 with shorter filaments and dehiscing by pores, 3 posterior minute and sterile. Pod cylindrical, large, black, 1–2 ft., with seeds in black resinous pulp, medicinal and economic; animal-dispersed.

*C. auriculata* a shrub on dry stony soils gives tannins.

**Poinciana regia**, Gold Mohur Tree, African, cult., with erect showy panicles of scarlet flowers; pods flat, 1–2 ft.

**Tamarindus indica**, a fine tree of C. Africa, naturalized and cult.; Lax racemes of 10–15 flowers; 3 post. petals only functional, 2 ant. minute; 3 post. stamens large and curved forwards, others as vestigia only. Pods as thick husks with brown acid pulp, fibres, and small brown seeds.

**Amherstia nobilis**, evergreen tree of S. Burma, cult.; leaves hang vertically when young. Inflorescences as pendulous racemes, many flowered; prophylls large and scarlet, 2 posterior sepals give a hooded segment, others simple; 3 post. petals, of which the median is a flag-segment with broad waved lamina with crimson and yellow blotch at end, 2 anterior as rudiments. Stamens 9+1; med. post. stamen reduced; 5 anterior long, and 4 short: Perigynous receptacle extended 40 mm. to a narrow nectary-tube; honey-bird pollinated. Pod flat and linear, 7 in.

**Bauhinia Vahlii**, a gigantic liana-form, destructive to Sal, &c.: stem to 100 ft. long, and 1–2 ft. diam., growing 50 ft. a year, with anomalous thickening. Leaves to 18 in., ‘cleft’  $\frac{1}{3}$  down: Flowers creamy-white, 5 petals and 3 fertile stamens; petals hairy,  $1\frac{1}{2}$  in. long. Pod 9–18 in., long, broad and flat, hairy, woody and bursting explosively.

**B. variegata**, a middle-sized tree of dry deciduous and hill-forest, cult.; Flowers large and showy, fragrant, white and pink: standard-petal darker or variegated, conspicuous, with 5 functional stamens. Pods long and slender.

**III. Mimoseae** (30/1000): a wholly distinct type of floral organization, familiar in *Acacia dealbata* (Mimosa), the Australian Silver Wattle. Foliage bipinnate, evergreen; inflorescence as panicles of small globular capitula, 8 mm., fragrant; flowers not all perfect, minute, with a dense cycle of 30 stamens, slender style, reduced valvate sepals and gamophyllous petals; actinomorphic, pollen in packets. Fruit a pod (2–3 in.) dehiscent, seeds non-endospermic. Elementary forms have larger flowers on a similar plan in more racemose spikes.

**Prosopis spicigera**, Jhand: a stunted thorny tree, gregarious in dry tracts of Punjab, &c., persisting by deep root. Flowers in slender spikes; stamens 10, anthers

with apical 'gland'. Pod with coriaceous husk, indehiscent, 5-10 in., seeds in sweetish pulp with contracted portions.

**Entada scandens**, a huge liana-form of Tropical sea-coast and hills: flowers pale-yellow, in crowded slender spikes. Stamens 10, with 'gland'. Pod immense, 2-4 ft., woody, 10-30 seeded, separating 'Cocci' from rim-framework, each with 1 flat seed, orbicular, polished, 2 in. diam.

**Xylia dolabriformis**, Pyingado, gregarious in deciduous forest, with Teak in Burma: Flowers pale-yellow, in long-stalked sub-globose heads, 20 mm. diam.: Pod thick, woody, xerophytic, 4-6 in. long, with characteristic curved valves, very explosive, 6-10 seeds.

**Acacia arabica**, Babul, a large tree of dry regions, deserts of Rajputana, and cult., gregarious, thorny, and often stunted. All parts used, wood exudes gum: Flowers golden-yellow, in globose heads,  $\frac{1}{2}$  in. diam.: Pod moniliform, flat, 3 in., with marked constrictions between the seeds, and covered with grey tomentum; taken by cattle.

Cf. *A. Senegal*, African sp. also cult. for Gum Arabic: *A. Vereh* of Sudan.

**A. Catechu**, Khair, middle-sized tree of dry deciduous forest and sides of streams: flowers in pale-yellow cylindrical spikes, 2-3 in. long; Pods thin, brown, and dehiscent, 2-4 in.: 'Cutch' of tannins from wood-chips.

**Albizia procera**, White Siris, a large deciduous tree, conspicuous near river-banks, also cult.: Flowers large, 10 mm., with delicate stamens. Pod flat, brown, strap-shaped, 4-8 in.: Young leaves with white tomentum.

**A. odoratissima**, Black Siris, a large tree, common in mixed forest, leaves dark-green, leaflets 10-25. Flowers 10 mm., in paniced corymbs, fragrant. Pod 6-8 in., smooth and flat, reddish-brown.

**A. Lebbek**, Siris, common and cult., avenues. Flower 1 in. long, in heads, white and fragrant. Pod, 8-12 in., thin and dehiscent, straw-coloured, rattling when dry in hot season.

**Pithecolobium dulce**, Karkapilly, spinous hedge-plant from Mexico: Flowers white, in small globose heads on long racemes. Pod 4-5 in., coiled, red and succulent husk; seeds in spongy edible pulp.

**P. Saman**, Rain Tree of S. America in damp situations and swamps, Burma.

**Mimosa pudica**, Sensitive Plant (Hort.), a spinous shrub, as weed from S. America: flowers in globular pale-violet heads, 20 mm. diam., Fruit-pods small, 1 in., constricted, spinous.

**Rosaceae** include representatives in Hill-forest, of such types as *Spiraea*, *Rubus*, *Rosa*, *Cydonia*, *Eriobotrya*, *Pyrus*, *Crataegus*, *Prunus* (*P. Amygdalus*, Almond; *P. persica*, Peach; *P. Puddum* of Himalya, &c. gives timber). Cf. also *Cotoneaster Simonsii* (Hort.) of Khasia Hills.

**Saxifragaceae** similarly afford representative species of flowering shrubs as *Philadelphus*, *Deutzia*, *Ribes*, &c. (Hort.).

**CALYCIFLORAL FAMILIES**, originally isolated by the 'calyx'-like character of a receptacular extension, commonly giving rise to phenomena of the 'inferior' ovary, and extended to cover other cases of special receptacular developments (cf. Rosales, Lythraceae, Cactaceae, Passifloraceae), are now seen to be a wholly empirical collection of highly specialized floral constructions in which the inferior ovary remains the most readily observed feature of the floral organization, also affecting the subsequent formation of the fruit. In such cases other special features previously emphasized acquire a subsidiary significance, as apocarp (Rosaceae, Leguminosae), indefinite androecium (Myrtales), even spiral construction of indefinite perianth (Cactaceae), eucyclus (Combretaceae), meiocyclus (Umbelliferae). Similarly all stages of reduction (tetramery, dicliny, apetaly) may also obtain in deteriorated mechanisms, and the fruiting-stage may present the full range of variety, from dehiscent carpels and capsules to one-seeded drupes, nuts and achenes.

So long as the exact relation of these isolated families to other series remains a matter of mere speculation, the section-heading is provisionally retained as the most generally convenient arrangement (*Gen. Plant.*, 1862).

**I. Myrtaceae** (72/2750) founded on the Myrtle of S. Europe, and extended along similar lines to a great tree-group with opposite gland-dotted leaves, a flower with indefinite stamens in tassel-formation, offering abundant pollen, no nectary, a syncarpous ovary with axile-placentation, and a single style. The floral organization is thus fundamentally Cistifloral (cf. Guttiferae), but the gynoeceum shows further advance in the complete 'fusion' of the style (with no trace of vestigial carpels), and the pocket-formation of the inferior ovary. Individual genera may present further elaborations of the type:—

***Eugenia caryophyllata***, Clove (*Jambosa Caryophyllus*), cult. in Tropics; evergreen with decussate leaves and axillary clusters of few flowers; tetramerous, receptacle-tube and sepals crimson, unopened buds (12 mm.) collected for eugenol; petals pink, shed as a cap on opening (5 mm.); stamens inarched in bud, divergent in flower as tassel-cluster, 8 mm. over all; single stout style, 3 mm., ovary with many ovules: fruit of enlarged receptacle, indehiscent, with 4 apical calyx-teeth: cf. *Eugenia*-forms with free petals (625), *Jambosa*, petals shed as cap (120), *Syzygium*, corolla a fused cap (140).

***Eugenia Jambos***, Rose-Apple, a small tree, cult.: the more generalized type; flowers large, greenish-white, 2–3 in. diam.; 5 petals free, stamens indef. tassel, 40 mm.; carpels 2, style 40 mm.: Fruit a berry-form, 1–2 in. diam., pink, edible.

***Eugenia Jambolana*** (= *Syzygium*), a large evergreen tree, cult. and widely distributed: Petals fused as a 'calyptra' thrown off on expansion in one piece, stamens as a white cluster: Fruit a purple-black drupe, juicy and edible,  $\frac{1}{2}$ –1½ in. long, with 1 or more seeds; taken by birds and flying foxes.

***Eucalyptus***, a great Australian genus (160) of tall evergreen trees, growth rapid, many introduced, cf.:—

***E. globulus***, Blue Gum of SE. Australia, cult. in Nilgiris, a tall tree with dimorphic foliage (juvenile leaves only decussate and waxy blue); flowers large, showy, 1–2 in. leaf-axils; sepals obscure, petals fused in massive calyptra, stamens indef. in tassel-formation, spreading; ovary 3–6 locular, many ovules; style simple: fruit hard and sclerosed, dehiscing apically; seeds numerous, small.

***E. amygdalina***, Red Gum, the tallest Dicot. 300 ft., similar in flower and fruit.

***Psidium Guayava***, S. American tree, Guava, cult.; flowers white, 1½ in. diam.; fruit enlarged inferior ovary, as succulent edible berry-type, 2 in.

***Lecythidaceae*** (18/130), based on S. American *Lecythis*, and separated by leaves spirally arranged, not gland-dotted, otherwise highly specialized lines of tropical forest-trees; organization essentially Cistifloral, with characteristic specialization in androecium: cf. *Lecythis*, Monkey Pot; *Couroupita guianensis*, small trees, flower massive, 5–6 merous, 3–4 in. diam.; the receptacle is extended unilaterally to

a broad thong with stamens, reflected over the primary androecium, hence sternetribal and nototribal: carpels 6, fruit a capsule, large and woody, dehiscing by a lid.

**Bertholletia excelsa**, Brazil Nut, tall tree of S. Amer. forest; calyx fused and splitting into 2 parts: flower 1 in., tetramerous; androecium with reflected region. Fruit a large wooden capsule, 4-locular, 2 rows of large seeds in each loc. a small cover cut off as lid with placental region. Seed as a large 'nut'; embryo massive, not differentiated, no endosperm.

*Barringtonia*, tall trees of strand-forest. *B. speciosa* of Malay, flowers 5-7 in., stamens 3-4 in. long. Fruit 3-4 in. diam.

*B. racemosa* S. India, flowers tetramerous, 2 in.; fruit ovoid  $2\frac{1}{2}$  in.

*Caraya arborea*, large deciduous tree of savannah-land: flowers tetramerous, 2-3 in. diam.; androecium gamophyllous below, with many staminodal filaments: fruit green, sub-globular, berry-type, 2-3 in. diam.

**Lythraceae** (21/450), based on herbaceous *Lythrum Salicaria* of Europe, and extended to tropical trees with similar floral organization; i.e. a receptacular tube which does not affect the ovary (still 'superior'): leaves opposite, 'calyx-tube' takes up sepals and petals (or stamens in part). The intercalated growth is protective and secretory; the flowers are still essentially Cistifloral, of reduced type, with axile placentation, and the fruits are dehiscent many-seeded capsules.

**Lagerstroemia parviflora**, large timber-tree of deciduous forest, associate of Sal, leaves opposite, simple: inflorescence few-flowered (3-6): flowers white, fragrant, 10-12 mm. diam., 6-merous; stamens 30-40, 5 antisept. (10 mm.) longer than the others (5 mm.); good cup-shaped receptacular tube (5 mm. diam.), stamens from base. Fruit a coriaceous capsule, 1 in., loculicidal with 3 stout valves: seeds numerous, winged, 15 mm.

*L. indica* of China, cult. for large rose-coloured flowers, 2 in. diam., 6 larger stamens, petals crumpled and crisped on margins.

**L. Flos Reginae**, chief timber-tree of Bengal and Assam, in moist situations; panicles of large purplish flowers 2-3 in. diam., 6-merous, petals crumpled in bud, stamens 100-150, all equal; carpels 6 (7-8), antiseptalous; Receptacle-cup massive, stamens borne  $\frac{1}{2}$  way up; Fruit a woody capsule, opening distally, loculicidally by 6 wide slits. Seeds numerous, angularly winged, 10 mm.

**Lawsonia alba**, Henna, a small hedge-shrub, often spinous; flowers greenish-yellow,  $\frac{1}{4}$  in., 4-merous, stamens in 4 antisept. pairs, capsule dehiscing irregularly.

**Woodfordia floribunda**, common gregarious shrub of dry hill-sides; Flowers clustered, bright red, 6-merous, zygomorphic: stamens 12 from base of receptacle tube.

**Sonneratia acida**, small tree of tidal creeks and Mangrove formation (Sundri-bans, &c.), Leaves obovate, opposite, light glaucous green: slender pneumatophores from horizontally spreading roots. Flowers perigynous, 6-merous, 2 in. diam., petals purple; fruits edible, 2 in. diam.

**S. apetala**, similarly common in Mangrove-formation, gregarious, to 50 ft., flowers tetramerous, apetalous, 1 in. diam.; fruit a capsule,  $\frac{3}{4}$  in.

**Rhizophoraceae** (15/60). Based on the Mangrove (**R. Mangle**) of Trop. Amer., characteristic of halophytic swamps and muddy sea-margins (Mangrove-belt). Flowers eucyclic, Discifloral, in few-flowered cymes, 4-merous, 1 in. diam. Stamens 4+4; ovary of 2 median carpels, each 2 ovules. Fruit 1-seeded, the seed germinating *in situ*, to a long (10 in.) pendulous embryo (mainly hypocotyl-axis), detached into mud ('viviparous').

**R. mucronata**, Tropics of Old World, similar, on sea-face of Mangrove-belt, with stilt-roots submerged at high-tide. Flower 1 in. diam., stamens 8; Fruit 2 in., and embryo with hypocotyl extending to 2 ft. or more.

**Bruguiera gymnorrhiza**, a large tree behind the *Rhizophora*, no stilt-roots, but respiratory 'knees'; also viviparous, hypocotyl 1-2 ft.

**Carallia integerrima**, large tree of inland forest; leaves coriaceous, glossy; Flowers in similar clusters of the same type, eucyclic, 6-8 merous, 4 carpels; fruit small, 1-seeded.



**Combretaceae** (15/450) of essentially tropical trees, with very characteristic advanced floral organization, eucyclic and Discifloral; petals may be wanting, but the inferior ovary is unilocular with 2 (or more) pendulous ovules, and single style-shaft. The fruits are 1-seeded nuts, indehiscent, and commonly angular or winged.

**Terminalia Chebula**, a large tree of mixed deciduous forest; Flowers small, greenish, in short panicles or spikes, apetalous, fly-pollinated, odour disagreeable, many staminate only. Fruit obovoid, or 5-angled,  $1\frac{1}{2}$  in. (Myrobalans), 1-seeded, without endosperm, cotyledons large and convolute (in transv. sect.), storing fat.

As important representative species, cf. :—

**T. Catappa**, Beach-forests of the Andamans, planted and cult. for edible seeds (Indian Almond); halophytic, fruit floating, 2 in., 2-angled, 2-winged with fibrous pericarp and strong sclerocarp.

**T. belerica**, large deciduous tree, 120 ft., common except in driest regions: fruit ovoid, 1 in., with hard sclerocarp, taken by animals.

**T. tomentosa**, a large deciduous tree, 100 ft. common, except in desert tracts, young branches and leaves with rusty pubescence. Fruit 2 in., with 5 broad longitudinal coriaceous wing-ridges, and hard bony sclerocarp.

**T. Arjuna**, a large buttressed tree, nearly evergreen, common on banks of streams, leaves coriaceous; fruit similar, more spindle-shaped, wings narrow.

**Anogeissus latifolia**, a large tree characteristic of dry deciduous forest, leaves turn copper-red in cold season. Flowers in small globose capitula ( $\frac{1}{4}$  in.), minute, apetalous, receptacle-tube elongated. Fruit very small, a samara, 2-winged, 5 mm., with remains of receptacle-tube as beak (4 mm.).

As types of particularly isolated series, cf. :—

**Hamamelidaceae** (18/50) based on *Hamamelis*, Wych-Hazel of N. Amer., commonly placed near Saxifragas from the receptacle-tube being partially free and the gynoeceum of 2 carpels, 2-loc., 2 styles, and fruit a capsule.

**Parrotia Jacquemontiana**, gregarious small Hazel-like tree of NW. Himalya, for wicker and bridge-rope: flowers diclinous, greenish-yellow, in clustered heads, apetalous, stamens 15; capsule  $\frac{1}{2}$  in., with stellate tomentum, 2-seeded, with horny dehiscent sclerocarp.

**Bucklandia populnea**, a tall evergreen tree of E. Himalya (Darjeeling, hill-forest); stipules large, enveloping the buds; flowers in clustered heads of 8–20, fused up; petals rudimentary or wanting; stamens 10–14, ovary with several ovules, seeds winged.

**Carica Papaya** (Papaw) of Caricaceae (2/30), of Tropical Amer., cult., a small soft-wooded tree with latex, single stem, leaves palmately lobed, to 2 ft. across, on long petioles held horizontally; stems with yellow bark and seal-scars; staminate inflorescence pendulous, staminate flower with white trumpet-receptacle and 5+5, stamens near top: carpellary flower with free white petals, conspicuous ovary, 5 carpels and 5 elaborate stigmatic branches, parietal placentation. Fruit succulent, with black seeds in sweet pulp. Endosperm stores fat. (Formerly classed with Passion-flowers, from fruit.)

**Tetrameles nudiflora** (Datisceae, 4/4), a tall deciduous tree of hill-forest, stem buttressed; flowers on bare stems in branched panicles, dioecious, tetramerous, 5 mm.; Staminate flower with 4 stamens, carpellary flower with 4 styles, and indefinite ovules on 4 parietal placentas. Capsules shed minute seeds.

**Opuntia Dillenii**, Prickly Pear of S. Amer. (Cactaceae, 20/1500). Branches as succulent-flattened cladodes in obovate segments, with leaf-points indicated by sharp spines (1 in.). Flowers of spirally arranged indefinite perianth above the inferior ovary, yellow; stamens indefinite, shorter than the 'petals'. Ovary with parietal placentation, many ovules. Fruit succulent, bird-dispersed, pear-shaped, with spines distally.

**Araliaceae** (51/660), type *Hedera*, includes *Aralia*, *Gamblea*, *Dendropanax*, following the general lines, with tendency to simple umbellate inflorescence-schemes in panicles.

**BICARPELLATAE** of *Gen. Plant.* (1876), a convenient assemblage of meiocyclic Gamopetalae (the main series), with 'superior' ovary and of 'hypogynous' construction of the type :—sep. 5, pet. 5, stamens 5, gynoecium of 2 median carpels, syncarpous. The flowers present a great range of floral mechanism and fruit-elaboration, and the section is largely separated into families and groups by conspicuous features of somatic organization (e.g. opposite leaves), and the construction of the gynoecium in terms of placentation, as also leading to different types of fruit-formation : the last may range from dehiscent 'follicles' to capsules and indehiscent achenes, schizocarps and cocci, berries and drupes. Families with opposite leaves and actinomorphic flowers may be taken first, as most readily identified by such obvious features : cf. :—

**Oleaceae** (20/390), founded on *Olea* (Olive) of S. Europe, extended to *Fraxinus*, *Syringa*, *Ligustrum*, *Osmanthus*, *Jasminum* (Hort.), distinguished by flowers ranging to tetramery, and in the limit apetalous (Ash), but the androecium remains constant at 2 stamens alternating with 2 carpels of the gynoecium, syncarpous with 2 ovules per loc. Fruit a capsule (*Syringa*) or berry (*Ligustrum*), 1-seeded samara (*Fraxinus*); including representative species as small trees and shrubs of hill-districts.

**Salvadora persica**, Mustard-tree, of Salvadoraceae (3/9), a small tree, 30 ft., of dry regions, cult., and as halophyte; evergreen with coriaceous leaves. Flowers greenish-white in lax panicles, tetramerous, stamens 4, ovary unilocular with 1 basal ovule. Fruit a red drupe, 1-seeded, with thin sclerocarp and pungent taste. Otherwise put with Disciflorae.

**Apocynaceae** (130/1000), a large family based on *Apocynum* of Medit. region, and extended to a wide range of tree-forms with usually opposite leaves, milky juice (latex) and flowers with convolute corolla and tube-mechanism, commonly moth-pollinated: the gynoecium of 2 carpels is fused distally in a common style-extension; these break away in fruit to give dehiscent 'follicle'-like pods (much in the manner of *Sterculia*). Seeds commonly packed in the pods with silky hairs subsequently utilized for wind-dispersal.

**Alstonia scholaris**, large evergreen tree of damp forest, leaves coriaceous, flowers greenish-white, in compact long-stalked cymose clusters. Corolla-tube 8 mm.; fruits slender pods, pendulous, 1–2 ft.; seeds with fringe of hairs.

**Holarrhena antidysenterica**, a small tree, common in deciduous forest, often gregarious; flowers white, fragrant, 1–1½ in. diam.; fruits slender pods, 8–14 in., 5 mm. diam., seeds with tuft of hairs (2 in.) at one end.

*Plumeria acutifolia* of W. Indies, cult., very milky, leaves spirally arranged. Flowers on bare stems, fragrant, large, white with narrow tube, and typical moth-type of mechanism; anthers at base of tube, 20 mm. from orifice.

**Wrightia tomentosa**, a small deciduous tree, flowers brownish, 1½ in. diam., with red corona-growths. Fruit a rough pod, 6–12 in. long; seeds linear, ½ in., with fine silky coma packing the interior.

**Asclepiadaceae** (217/1700), similarly with opposite leaves, latex, meiocyclic flowers, and 2 carpel-pods divergent in fruit, pass on to elaborated mechanism with coherent pollinia, retinaculum ('spoon' or 'clip') as stigmatic parts taking out pollen from loculi of adjacent anthers. Fly- or moth-pollinated, of highest floral organization in Dicots.; cf. *Periploca* (Hort.) spoon-type, nectary on petals; *Asclepias* (Hort.) clip-retinaculum type; *Ceropegia* (Hort.) as 'fly bottle' trap-type. No timber-trees, but many shrubs and lianoid (*Periploca*), also herbaceous succulent (*Stapelia*).

**Loganiaceae** (32/550) based on *Logania* of Australia, covers the case of opposite leaves, actinomorphic, meiocyclic flowers, no latex, and fruits as many-seeded capsules, as a more generalized group with great range, hence liable to take in forms not included in the more specialized families. Cf. *Buddleia globosa* of S. Amer. (Hort.), simple flowers in orange balls, 20 mm. diam.; *B. variabilis*, violet spicate

panicles, flowers actinomorphic, 4-merous, 8 mm. diam. : Fruit a small capsule, 8 mm. (Hort.), bee and butterfly-pollinated; seeds small with wing-extension.

**Strychnos Nux-vomica**, common evergreen tree of S. India, &c., leaves glossy, flowers greenish-white, in cymose clusters: corolla tubular, 8 mm.; fruit a large orange berry (1-2 in. diam.) with 8-9 massive seeds (like grey buttons), 15 mm. diam., with solid endosperm.

**Fagraea obovata**, a small tree, often epiphytic (as on Teak), with clasping roots: Flowers large, fragrant, with tube 1-1½ in. long. Berry glossy-green to black, 1-1½ in.

**Boraginaceae** (85/1550), a large order, mainly herbaceous, leaves spirally arranged, flowers typically pentamerous and actinomorphic; gynoecium of 2 carpels, each 2 ovules; style gynobasic and fruit separating as 4 dry mericarps (cocci); cf. *Anchusa*, *Symphytum*, *Myosotis* (Hort.); a wider range in:—

**Cordia Myxa**, deciduous tree of shady ravines in Sub-Himalya, &c., largely cult.; Flowers, small, white, 10 mm., in clustered cymes; styles 2, each 2-fid, not gynobasic; Fruit a drupe, ½-1 in., glossy-yellow, subglobose, turning black, with rugose 'stone' in sweet viscid translucent pulp; taken by birds and monkeys: Seeds 1 or more, sclerocarp splitting off 'valves' on germination.

**Ehretia laevis**, common in deciduous forest; flowers in unilateral cymes, white, 5 mm.; style 2-fid, not gynobasic; Fruit a small orange-red drupe, 5 mm. with 3-4 pyrenae.

**Bignoniaceae** (100/500) essentially tropical tree and liana-forms, leaves commonly opposite, flowers handsome, more or less zygomorphic, stamens reduced to 4 (2) in correlation; gynoecium of 2 median carpels, the ovary 2-locular with a large number of ovules on compound placentas, appearing (in transv. sect.) as 2-lobed in each loculus. Fruit typically a dehiscent capsule with characteristic winged seeds; two valves separate from the median placental tracts (dissepiment).

**Stereospermum chelonoides**, a large tree of moister deciduous forest; Flowers fragrant, yellow marked with red, ¾ in. long. Capsule a slender pod, 10-30 in., and ½ in. diam., seeds wedge-shaped, sunk in 'notches' of a corky cylindrical dissepiment (like a jointed snake), with wings at each end (1 in. over all) shaped to the curve of the dissepiment.

**S. suaveolens**, in drier districts and with Sal. Fruit 1-2 ft., ¾ in. diam., dark grey and speckled; valves hard and thick, seeds flat and winged.

**S. xylocarpum**, deciduous tree of Central Provinces; capsule to 3 ft., over 1 in. diam.; woody and tubercled, seeds 1 in., winged ¼ in. at each end.

Cf. also:—*Dolichandrone falcata*, with white, nearly regular, trumpet-shaped flowers, 1-1½ in. tube; *Spathodea campanulata*, W. African Tulip-Tree, with conspicuous zygomorphic red-and-yellow flowers; *Millingtonia hortensis*, Burma, cult., a large tree with fragrant white flowers; corolla-tube 3-4 in., slender; 4 stamens at base of tube; fruit capsule 12 in., seeds with 3 transparent wing-ridges. *Oroxylum indicum*, a small deciduous tree, leaves bipinnate, 3-5 ft.; flowers purplish, corolla 2-3 in., trumpet-shaped: capsule flat, 1-3 ft. and 3 in. broad, flattened in the plane of the dissepiment; seeds with a papery netted wing, 3 in. broad, flat with a flat green central embryo.

**Acanthaceae** (173/2050) based on *Acanthus* of S. Europe, with markedly zygomorphic flowers, 4 stamens, and dehiscent fruits; seeds on a special type of placenta. Mainly shrub and herbaceous types, extended to a large no. of tropical shrubs and herbaceous plants, the most important:—

**Strobilanthes** in many species (180, Indian 21), as gregarious shrubs of under-wood, or on open hill-sides as dense scrub: more or less monocarpic and flowering periodically, colouring the landscape violet-blue; dying down after fruiting and allowing regeneration of forest-trees. *S. auriculatus*, 4-6 ft., with Sal, flowering every 6 years: stem quadrangular, flowers blue, in bracteate spikes 3-5 in. long; others in hill-country, with representative species.

**Verbenaceae** (67/760) founded on European *Verbena*, and extended to a wide

range of forms with similar floral construction ; leaves opposite, flowers pentamerous, more or less zygomorphic, stamens 4, carpels 2 median ; the ovary generally with 2 ovules per loculus, and separating 4 cocci, dry or succulent ; without the gynobasic style of the Labiatae.

Cf. a wider range in :—

**Vitex Negundo**, a deciduous shrub of drier regions and waste places, planted in hedges, &c. Flowers small, violet, in elongated terminal panicles of opposite cymes ; corolla  $\frac{1}{4}$  in. diam., 2-lipped ; Fruit a drupe, sclerocarp 1-4 seeded.

*V. altissima*, a large evergreen tree of W. Ghats : Flowers white, drupe  $\frac{1}{4}$  in., also *V. pubescens* and *V. leucoxylo*n, deciduous, of S. India, with axillary cymes only, and small drupes similarly 4-locular : cf. *Clerodendron*, *Aloysia* (Hort.).

**Tectona grandis**, Teak, a large tree in mixed deciduous forest of both Peninsulas, 150-190 ft. with 100 ft. bole, and 7-8 ft. diam. ; Leaves opposite, lamina 1-2 ft., with grey stellate tomentum, on quadrangular shoots : Inflorescence as terminal erect panicles (1-3 ft.), conspicuous in the rainy season, of small white flowers, actinomorphic, 5-6 merous, with 5-6 stamens, fly-pollinated. Fruit a hard nut, indehiscent, with corky apex and felt of hairs, further enclosed in the dry saccate persistent calyx (1-1 $\frac{1}{2}$  in. diam.), 4 seeds included : dispersed by water-flotation ; in germination the sclerocarp splits off 1 or more 'valve'-pieces laterally, 1-4 seedlings from a nut.

**Gmelina artorea**, a large deciduous tree (100 ft.) of Sub-Himalya, &c. ; Flowers yellowish-brown, pentamerous, all parts softly hairy ; corolla 1-1 $\frac{1}{2}$  in., zygomorphic. Fruit a yellow drupe, 1 in., taken by cattle ; sclerocarp dehiscing by valves.

**Avicennia officinalis**, a large evergreen tree, halophytic in Mangrove Zone (Sundribans, &c.), common and often gregarious, with respiratory roots. Leaves with silvery tomentum ; flowers small, 10 mm., yellow, zygomorphic, stamens 4 ; ovary 4-locular, 4 ovules suspended from central placenta. Capsule dehiscing by 2 woody valves, 1-seeded only, and the seed often more or less viviparous ; seeds floating and germinating, young plants fixed in mud by stiff recurved hairs on the hypocotyl.

**Lantana aculeata**, a Verbena-like spinous shrub of S. Amer. (Hort.) introduced and a pest in S. Ind. and Ceylon. Flowers, 5 mm. pink to orange-yellow ; fruit a small black drupe, 6 mm., taken by birds.

**EUCYCLIC GAMOPETALAE** (Heteromerae of *Gen. Plant.*, 1876), conventionally including at least 3 distinct groups of divergent series of gamopetalous construction with very characteristic features, classified as Ericales, Primulales, Ebenales (*Gen. Plant.*).

**I. Ericales** include Ericaceae (67 1350) with Rhododendreae and allied sections in which the full eucyclic formula normally obtains, together with full number of antipetalous carpels: minor irregularities are to be allowed for; e.g. *Erica* may be tetramerous, *Calluna* is only slightly gamopetalous, *Vaccinium* has an inferior ovary. Porous dehiscence of the anthers and the general occurrence of 'trigger-mechanism' has continued the older term of Bicornes (Eichler, 1875). *Arbutus Unedo* affords a typical arboreal example of *Erica*-organization, with white bell-shaped flower, 10 mm., and succulent red berry-fruit,  $\frac{3}{4}$  in. diam.; cf. :—

**Rhododendron arboreum**, a small evergreen tree of W. Himalya, at 5,000–8,000 ft., semi-gregarious with *Quercus incana*; garden forms and hybrids of similar organization. Flowers deep crimson, shortly stalked in sub-globular umbel-like corymbs; calyx rudimentary, corolla zygomorphic, with broad tube, horizontally projected; odd petal posterior, spotted and grooved to nectary-lobes of disc; anthers dehisc by pores, in sternotribal series (5+5), pollen in tetrads, cohering in silky threads; pollination by moths, &c.: gynoeceum syncarpous, with axile placentation, many ovules (varying to 6–10-mery). Fruit an erected capsule, 1 in., dehiscing by valves divergent from central placental shaft; seeds minute, 1 mm., winged.

*R. campanulatum*, evergreen shrub, densely gregarious at the upper limit of trees (9,000–14,000 ft.): flowers purple in lax corymbs, long-stalked, similar in organization.

**II. Primulales**, grouped around the European *Primula*, have been extended to types in which the ovary presents similar construction with 'free central' placentation, based on 5 carpels, with 5 antipet. stamens (Primulaceae, 28/500): The Plumbaginaceae (10/260) include forms reducing to one ovule only in the ovary; cf. *Plumbago* (Hort.), *Armeria*; while the Myrsinaceae (23/1000) normally retain 10 functional stamens, or 5 fertile and 5 staminodal. The ovary indicates 5 carpels with many ovules.

**Aegiceras majus** (Myrsinaceae), a small evergreen tree, 20 ft., gregarious in Mangrove-forest, presents the viviparous habit. Flowers small, white, 10 mm., actinomorphic, with convolute corolla, 5 stamens antipet., the anther loculi transversely 12–15 septate. Fruits 1–2 in. long, curved like horns, 1-seeded, the embryo commonly germinating on the tree.

**III. Ebenales** include more generalized residual groups, again falling into 3 divergent series as Ebenaceae (5–320), timber-trees with flowers much reduced and commonly declinous and apetalous; Sapotaceae (31/600) trees with latex; and Styracaceae (6/110) trees with resin; hence many economically important.

**Diospyros Ebenum** (Ebenaceae), Ebony Tree of S. India, a large tree of dry regions, commoner in Ceylon, duramen uniformly and intensely black and hard. Flowers dioecious, tetramerous; staminate small and clustered, with 4-toothed calyx and 8 stamens with unequally paired anthers; carpellary flowers solitary in leaf-axils, carpels 4. Fruit a sub-globular berry,  $\frac{1}{2}$  in. diam., in persistent woody cup of calyx, 5–8 seeded, with sweet pulp.

*D. melanoxylon*, common in deciduous forest, 50 ft., similar to *D. tomentosa* (with broader leaves) Ebony Trees of N. India, duramen less uniformly black, more or less gregarious in dry forest. Fruit 1 in. diam., seeds 3–8 in sweet pulp, taken by birds, bats, &c. Stamens simple and endosperm ruminated. *D. Kurzii*, Zebra-wood of moist forests of Andamans, large evergreen tree; flowers declinous, tetramerous, corolla 4 mm., velvety externally, fruits  $\frac{1}{2}$  in. diam.

**Sapotaceae** include remarkable tree-types with characteristic floral organization, essentially eucyclic, but ranging to 4–6–8-mery, or with effect of multiple corollas by

secondary appendages to petals; apparently in some cases the androecium is in more than two whorls, or the inner series is staminodal. Fruits as berry-forms with 1 or several seeds. The family is essentially tropical, and was based on *Sapota* of Trop. Amer. the fruit of *Achras Sapota*, Sapodilla.

**Palaquium Gutta**, Gutta Percha, a large tree of evergreen forest, Malay: leaves and shoots with rusty tomentum; flowers small, clustered in leaf-axils, 6-merous; stamens 12-18, ovary 6-locular. *P. oblongifolium*; fruits larger, similar, exploited.

**P. ellipticum**, a tall tree, 100 ft., of W. Ghats (4,000 ft.), Flowers 1 in., stalked in the manner of *Bassia*; stamens 12-18, Fruits  $1\frac{1}{2}$  in.

**Bassia latifolia** (= *Illipe*), a large tree of deciduous forest of C. Ind., cult. (Mohwa); leaves and flowers clustered at ends of branches; flowering on bare stems with the young leaves; flowers on 2 in. stalks, with massive fleshy corolla-tube, more or less drooping, with small floral aperture, soon dropped, and taken by animals. Calyx of 4-5 free segments, petals 8-10, corolla-tube 8 mm. by 10, and 2 mm. thick, with small free lobes. Androecium of 16-20 (30) stamens in 2 (3) alternating series, enclosed in corolla-tube. Gynoecium of 8 carpels, 8-loculi, each 1 ovule: Style 30 mm. projecting from corolla-tube; honey-secretion copious. Fruit a greenish-yellow berry, 1-2 in. with 1-4 seeds. Cf.:—

*B. longifolia*, representative species of S. India, essentially similar.

*B. Parkii* (= *Butyrospermum*) of W. Africa gives 'butter' from cotyledons of large seeds; 8-merous, with 8 functional stamens, and inner series of 8 petaloid staminodes. Fruit with 1 large seed. Cf. *B. butyracea* of E. Sub-Himalya.

**Mimusops Elengi**, a large evergreen tree of dry forest of S. India, much cult.; Flowers white, fragrant, 1 in. diam.; calyx 4+4, corolla of 8 petals, each with 2 petaloid appendages, the former convergent on stamens, the latter divergent; stamens 8 antipet., and 8 alternating staminodes: style simple, ovary with 8 antipet. loculi, each 1 ovule. Fruit 1 in., pale yellow, 1-seeded. (The corolla with androecium shed in one piece, with 'daisy-effect' in daisy chains.)

**M. hexandra**, a small evergreen tree of C. and S. India (100 ft. in Ceylon), much cult., Flowers 6-merous,  $\frac{3}{4}$  in. diam., petals yellow, with bilobed white accessory segments; stamens 6, and 6 staminodal processes. Fruit  $\frac{1}{2}$  in., yellow.

*M. littoralis*, a large evergreen tree of sand-hill coast-forest of Andamans, flowers 6-merous, fruits  $1\frac{1}{2}$  in., with several seeds.

*M. globosa* of Trop. S. Amer., Balata, flowers 6-merous of similar construction, 13 mm. diam., daisy-like on long-stalks, petals with paired accessory lobes. Stamens 6 antipet. with 6 staminodes.

---

**INFERRAE** (*Gen. Plant.*, 1876) comprising the most highly organized of the gamopetalous phyla, presenting the additional specialization of an 'inferior' ovary (epigyny), as also the limiting condition of meiocycly (= Tetracyclae) of the type  $5S+5P+5A+2G$ .

**Rubiaceae** (346/4500), a remarkable group, founded on the European *Rubia* (Madder), and extended to a wide range of tropical trees with opposite leaves and generalized actinomorphic flowers on these lines. Leaves 'opposite and stipulate' have been regarded as more essential than reduction of ovary-contents or axile placentation.

**Cinchona officinalis**, evergreen tree of mountain-forest of Andes, cult. in vars. (Nilgiris); flowers small in red clustered cymes, 5-merous; corolla tubular, 15 mm., silky, valvate in bud; style slender, with 2 short stigmatic lobes. Fruit dehiscing by 2 valves, along septa; seeds many, small and flat, with membranous wing on margin.

**Hymenodictyon excelsum**, a large tree of deciduous forest, leaves simple, petiolate; Flowers white, fragrant, in dense cylindrical paniced systems; corolla-tube

slender; style long, exerted; moth-type of pollination. Capsule  $\frac{3}{4}$  in., 2-valved, dehiscent loculicidally; seeds small, winged marginally.

The Naucleae comprise a special section with globose aggregated inflorescences as capitula of closely-packed flowers:—

**Anthocephalus Cadamba**, a large deciduous tree with soft wood, of outer hills and evergreen forest, planted and cult., leaves coriaceous, flower-heads large, terminal solitary,  $1\frac{1}{2}$ –2 in. diam., as yellow balls in the manner of *Platanus*. Inflorescence-receptacle enlarged in fruit to orange fleshy pseudocarp (taken by animals and birds), with closely packed capsules; seeds not winged.

**Adina cordifolia**, a tall tree, common in deciduous forests, leaves cordate and acuminate (Poplar-like); flower-heads 1 in. diam., yellow, corolla 5-merous, hairy.

**Stephegyne parvifolia**, common deciduous tree of outer Himalya, often gregarious: Flower-heads 1 in. diam., fragrant, greenish-yellow. Flowers pentamerous, corolla-tube 7–8 mm., style long, projecting, 12 mm.; stigma club-shaped; nectary as conspicuous disc-collar. Fruit-heads globose,  $\frac{1}{2}$  in., with numerous small 2-valved capsules; seeds 2 mm., pointed and winged at both ends.

**Gardenia latifolia**, a small tree, floral mechanism on large scale, distinct moth-type of pollination: corolla pale-yellow, fading orange; petals 5–9, tube 2–3 in. long. Fruit 2 in., drupaceous, indehiscent, with thin hard sclerocarp. Seeds numerous on 4–5 parietal placentas.

**Coffea arabica** (Coffee), a small tree, 15 ft., of Trop. E. Africa, cult.; Flowers in axillary clusters, corolla greenish-white, ranging 4–9-merous, tube 6–8 mm., styles and anthers projecting. Fruit a crimson drupe,  $\frac{1}{2}$  in. diam., with 2 pyrenae; sclerocarp cartilaginous only; seed 10 mm., with solid horny endosperm.

*C. liberica* of W. Africa, larger leaves, flowers 6–9-merous; fruit 1 in. diam., crimson, seeds similar; disease-resisting.

**Compositae** (806/13,100) a huge series of predominantly herbaceous types in temperate regions or on mountain ranges; without definite timber-trees and of minor importance in forestry. For shrubby forms (Hort.) cf. *Olearia Huastii* of New Zealand. Flowers white in corymbose panicles of few-flowered (7–12) capitula, with 3–5 ray-florets (July).

**Vernonia arborea**, a small tree, 60 ft., of Hill forest of S. India; Flowers in capitula (1–6), all tubular: pappus of white hairs, 6 mm.

**Leucomeris spectabilis**, a small deciduous tree of NW. Himalya, bark white, leaves coriaceous, felted white underneath; capitula 4–8 flowered, in terminal corymbose panicle, 6 in. diam.

*Blumea balsamifera*, a large aromatic shrub, gregarious, with silky tomentum, in the manner of *Artemisia*. Capitula of yellow flowers,  $\frac{1}{4}$  in., clustered in a leafy paniced system; pappus red: yields camphor.

*Senecio* a characteristic genus (1,200 sp.) of great range; involucre of a single contact-cycle, ray-florets normally present, pappus simple; represented by woody climbers in Hill-forest.

As **APETALAE** may be conveniently grouped families in which there is some suggestive evidence that the petaloid condition has been lost, and that they may be more or less related to existing polypetalous forms. In absence of very decisive evidence, these may include:—**Lauraceae**, referred to the **Polycarpicae** near **Berberidaceae**, **Myristicaceae** near **Anonaceae**: the great series of the **Euphorbiaceae** as a branch of the **Eucyclic Discifloral** section (**Geraniales**), with the **Buxaceae** (**Sapindales**): the **Platanaceae** as petaloid and apocarpous suggestive of the **Saxifrage-alliance**: the **Thymeleaceae** as reduced **Discifloral** types, and the **Chenopodiaceae** generally referred to the **Centrosperm** series with **Caryophyllaceae**.

**Lauraceae** (40/1000) founded on *Laurus nobilis*, Bay, of **Medit. region**; evergreen, flowers in decussate clusters, dioecious, dimerous, apetalous; Staminate flower of 2+2 perianth, and 10 stamens (4+2+2+2) with paired glandular appendages on the 4 inner, and valvate dehiscence of 2 anther-loculi: Carpellary flower of 2+2 perianth, 4 staminodes (diagonal), and gynoecium of 1 carpel with 1 suspended ovule. Fruit a black berry,  $\frac{3}{4}$  in., aromatic, with 1 seed without endosperm. The family is extended to a wide range of tropical forest-trees, in which the full type of flower is hermaphrodite and trimerous, characterized by the peculiar valvate anthers and the limiting term of the gynoecium.

**Cinnamomum zeylanicum**, Cinnamon, a large tree of **S. India** and **Ceylon**, cult. and coppiced; leaves coriaceous, aromatic; flowers in paniced clusters, greyish, 5 mm.; Perianth 3+3, stamens 4-locular, 4-valved, in alternating series 3+3 introrse, and 3 extrorse, 2-glanded, followed by 3 staminodes. Style and stigma simple, ovary with one anatropous ovule suspended. The receptacle is crateriform (perigyny), and the construction suggests a relic of a once more complex organization. Fruit a dark-purple berry, 1 in. long, taken by birds.

**C. Tamala**, Cassia-Cinnamon, evergreen tree of **E. Sub-Himalya**, with glossy aromatic leaves. Flowers yellowish-white, 6 mm. diam.; Berry black,  $\frac{1}{2}$  in., fragrant.

Cf. *C. Camphora*, a large tree of **Japan** and forests of **Formosa** (100 ft.), cult.; camphor distilled from all parts.

**Machilus bombycina**, Soom, gregarious in valley-forest of **Assam**, largely cult. (Muga-silk); flowers of similar type. Perianth 10 mm.; berry  $\frac{1}{2}$  in.

**Litsaea polyantha**, a tree of **Sub-Himalya**, also associated with **Soom** and cult.; Flowers trimerous but dioecious, in decussate groups of 5 (in the manner of *Laurus*); stamens all introrse and 4-valved; carpellary flowers of 3+3 perianth and typical ovary. Fruit on elongated pedicels and appearing clustered.

**L. zeylanica** (= *Tetradenia*), a small evergreen tree of **Hill-forest**, **S. Ind.** and **Ceylon**: Flowers in compact axillary clusters, perianth 4-lobed, stamens 6, 2 innermost biglandular, all 4-valved.

**Beilschmiedia Roxburghiana**, evergreen tree of **Assam**, &c.; Flowers hermaphrodite, trimerous; Perianth 3+3, 10 mm. long; stamens 3+3 introrse, 3 extrorse, and 3 staminodes, the 3rd whorl biglandular (as in Cinnamon), but the anthers dehisce by 2 valves only (as in *Laurus*). Ovary typical, fruit about 1 in.

**Myristica fragrans**, isolated type of **Myristicaceae**, following similar extreme phases of reduction. Evergreen tree (30–60 ft.) of **E. Indies**, and cult.: Staminate flowers in paniced cymes, perianth trimerous, gamophyllous, and a staminal column with 20 or so fused anthers: carpellary flower of perianth including 1 carpel with 1 basal anatropous ovule: Fruit a large yellow berry-form, 2 in., with 1 large seed (Nutmeg) with ruminated endosperm and scarlet fenestrated aril (Mace).

**Euphorbiaceae**, a series of **Eucyclic Geraniales**, in all stages of diclinous specialization: Staminate flowers may be wholly aberrant, and the carpellary flower attains the limit of a **Tricoccus**-fruit of characteristic construction, syncarpous, superior, of 3 carpels, with 2 (or 1) suspended ovules in each locus, raphe internal, and 3 style-branches (often bifid); Fruit normally a dry dehiscent, explosive, capsule,



3-seeded: Endosperm stores oil, and the seeds show a 'caruncle' as a cap over the micropyle.

A vast order (208/4500) with many forest-trees, though not of first-class timber production, ranging to desert-succulents (leafless and with spiny stipular thorns) and herbaceous forms of N. Temp. woodland (*Mercurialis*). The genus *Euphorbia* (600) as the extreme case (with *Cyathium*) affords little idea of the entire series. The structure of the gynoecium is most constant: cf. *Mercurialis* with 2 carpels; 5 carpels, antipet., in *Wicklandia* of Seychelles; more indefinite in *Hura*. Though predominantly apetalous, many genera retain petals; as a series typically fly-pollinated. As special feature note stipules and their relation to extrafloral nectaries. For more elementary stage of flower, cf. first:—

**Jatropha Curcas**, herbaceous form of Trop. Amer., cult.; Flowers in axillary panicles, small, of Discifloral habit: staminate flower 5 sep., 5 pet., 5+5 stamens and 5 extrastaminal disc-lobes: carpellary flower 5 sep., 5 pet., disc-lobes and staminode rudiments, ovary with 3 branched stigmatic lobes and 3 loculi each 1-seeded: fruit a capsule,  $1\frac{1}{2}$  in.

**Manihot Glaziovii**, Ceara Rubber, of drier tracts of Brazil, cult. in less humid stations than *Hevea*. Leaves palmately cut in 5-7 deep segments; flowers monoecious in terminal panicles, 1 in.; staminate flower apetalous, 5 sep. as gamophyllous bell, purplish inside, 5+5 stamens and 10 yellow disc-lobes; carpellary flower gamosep. of 5 segments. Fruit 1 in. diam. with polished mottled seeds.

*M. utilisissima*, Manioc (Tapioca).

**Hevea brasiliensis**, Pará rubber, a large evergreen tree of Amazon swamp-forest, leaves trifoliate; flowers, small (5 mm.) in large panicles; staminate flower 5 sep. and 5+5 stamens as anthers sessile on central 'column'; nectary as 10-lobed disc: carpellary flower of gamosep. calyx and ovary with bilobed stigmas and 3 ovules. Fruit a large tricoccus-capsule, 2 in., seeds large (1 in.) mottled as in *Ricinus*.

**Ricinus communis**, soft-wooded tree of Trop. Africa, cult. as annual for Castor Oil. Leaves large, palmately lobed; inflorescences axillary, reduced to few-flowered panicles: staminate flower of 5 sep. and a multibranched androecial region (15 mm.) with anthers on all end-ramuli (one of the most aberrant staminate constructions): carpellary flower a conspicuous tricoccus-ovary with shaggy or spinous emergences. Capsule explosive, seeds mottled, with distinct caruncle, well-defined embryo, endosperm with oil and aleurone.

Cp. *Hura crepitans*, Sand-box tree of W. Indies; carpels 15-20, capsule explosive, 3 in. diam.

**Bischofia javanica** (= *trifoliata*), deciduous tree of damp forest of Sub-Himalya. Flowers dioecious, apetalous; staminate flower of 5 sepals and 5 superposed stamens, no disc-lobes, but a rudimentary central column: carpellary flower with ovary 3-locular and linear styles. Capsule a globose, succulent berry,  $\frac{1}{4}$  in. diam., with parchment-like sclerocarp.

**Bridelia retusa**, a large tree of deciduous forest, leaves coriaceous, elliptical; Flowers yellow, clustered on slender spikes; staminate flower with 5 stamens on slight column, and conspicuous disc: carpellary with 2-locular ovary and bifid styles. Fruit a drupe,  $\frac{1}{2}$  in., sweet, purple-black, edible, and taken by birds.

**Mallotus philippinensis**, a small evergreen tree of Sub-Himalya, common in Sal forest; Flowers dioecious, 5 mm., in paniced spikes; staminate flower with 20-30 stamens; carpellary with conspicuous papillose sessile stigmas. Capsule 3-lobed, covered with glandular hairs secreting a red resin (Kamela-powder giving an orange dye).

**Sapium sebiferum**, Chinese Tallow tree, cult. in NW.; flowers in spicate racemes, monoecious, with the carpellary flower at the base of the spike; style with 3 long spreading stigmas; staminate flower of 2 stamens only and perianth rudimentary. Capsule with 3 seeds, a thick layer of fatty material surrounding them.

**Putranjiva Roxburghii**, evergreen tree of river-banks, cult., leaves coriaceous,

flowers dioecious. Staminate flower of 3 sep. and 3 stamens; carpellary with 3 enlarged papillose stigmas. Fruit a drupe, taken by deer, with one characteristically rugose 'stone' (necklaces), sclerocarp very hard, splitting on germination, 1-seeded.

**Excoecaria Agallocha**, a small evergreen halophytic tree of Sundribans and tidal forest, 40 ft.; flowers minute; staminate in yellowish-green catkins with long stamens 3; carpellary 3-merous. Capsule to 1 in. diam., 3-lobed, and separating into 3 cocci from central axis. Latex blistering.

**Cleistanthus collinus**, a small tree of S. India, on dry rocky ground, as coppice. Flowers yellowish-green in small axillary clusters. Capsule  $\frac{3}{4}$  in., woody with 3 seeds.

**Phyllanthus Emblica**, common tree of mixed deciduous forest with light feathery foliage; leaves small and pectinated on D.V. twigs, looking like pinnate leaves when young, and shed as phyllomorphs. Staminate flower 6-parted with 6-lobed disc. Carpellary with 2 ovules in each loculus. Fruit globose, fleshy,  $\frac{3}{4}$  in. with 6-ridged sclerocarp and 6 seeds. Fruits collected as Emblic Myrobalans.

**Buxaceae** (6/30), based on *Buxus* of S. Europe, differs in floral organization, also declinous (monoecious), apetalous; evergreen, with decussate leaves and reduced axillary racemes: staminal flower dimerous with 4 stamens; carpellary terminal, of 3 carpels with 3 divergent stigma-lobes; 2 ovules suspended in each loculus, raphe external. Fruit a dry capsule, discharging 6 seeds; seed with a small caruncle: cf. *Buxus sempervirens* (Hort.) and *B. Wallichiana*, very similar in Hill-forest, Himalya, at 4000 ft.

**Platanaceae** (1/6), based on *Platanus*, Plane, now generally accepted as petaloid with minute petals, declinous with reduced construction.

*P. orientalis*, a large deciduous tree, cult., NW. Himalya; leaves deeply 5-7 lobed; fruiting capitula spherical,  $1\frac{1}{2}$  in. diam., 5-6 in one system. Achenes hairy, 1-seeded, wind-dispersed.

**Hernandiaceae** (4/24), a small series of trees with anomalous characters, apetalous, the reduced flowers with irregular number of parts. The anthers dehisce by 2 valves, and the ovary is inferior with 1 suspended ovule; commonly included near Lauraceae (Engler, 1891).

**Gyrocarpus americanus**, a deciduous soft-wooded tree of sea-coast throughout the tropics: flowers in dense clusters on paniced systems of many staminate and few hermaphrodite: the latter of 4-parted perianth and sessile stigma. In fruit 2 larger perianth-segments extend as leafy lobes, 2-3 in. long, at the end of the ovoid velvety fruit,  $\frac{3}{4}$  in., to constitute spinning-mechanism suggestive of a Dipterocarp.

**MONOCHLAMYDEAE** include groups in which the floral organization is apparently primitively 'apetalous', in the sense that the essential floral organs are invested by a simple perianth as one contact-cycle of protective leaf-members. In all cases associated features of extreme reduction prevail in the general construction (dicliny, dimery, trimery), and may be combined with extreme specialization in the gynoecium (dicliny, dimery, syncarpy, inferior ovary, and reduced output of ovules and seeds). Such phenomena suggest that little reliance can be placed on these features as indicating primitive nature, and many extreme cases remain so isolated that any serial arrangement is wholly arbitrary. The individual families are usually distinguished by some one dominant character, the exact bearing of which may be wholly vague. A rough distinction may always be drawn between types with simple floral receptacle and those in which epigyny has been attained, and special cases of gynoecium-elaboration may be isolated.

**Urticales** (Engler, 1912, = *Urticinae*, Eichler, 1878), a large section conveniently grouped around the familiar *Urtica* (Sting Nettle) of the N. Temp., and extended to include a vast series of types characterized by advanced flowers (predominantly diclinous and dioecious, apetalous and dimerous) with the gynoecium as the limit of syncarpy (2 carpels), still 'superior', but containing only 1 ovule, and setting 1-seeded indehiscent fruits.

**I.** In the **Urticaceae** (41/500) the ovule is typically orthotropous with *basal* placentation, as the most special case; few are shrubby. Tropical herbaceous Nettles sting badly (*U. stimulans*, *U. urentissima*).

**Laportea crenulata**, a small tree of Hill-forest, very virulent; leaves elliptic, may be entire; flowers small (3 mm.) in loose axillary panicles, all parts with stinging hairs. *Girardinia zeylanica*, fibres as textile retain 'stinging' properties.

**Boehmeria nivea** (Ramie, Rhea) of Malay, cult., monoecious, herbaceous and shrubby, cult. for fibre of annual shoots (6-10 ft.), leaves serrate, with drip-tip; important textile.

**II.** **Ulmaceae** (13/132), based on *Ulmus*, Elm, with small clusters of *hermaphrodite* flowers, produced in spring before the leaves, of pentamerous type (per. 5, stamens 5, carpels 2), with 1 ovule suspended, micropyle upward; fruit a winged samara, seed without endosperm: cf. :—

**Ulmus Wallichiana**, a large deciduous tree of NW. Himalya (at 1-2 miles elevation) in damp ravines. Flowers in globose clusters, perianth 4 mm.; samara  $\frac{3}{4}$  in. diam. with seed centred.

**Holoptelea integrifolia**, a large deciduous tree of Sub-Himalya and hill-regions, with entire leaves; flowers hermaphrodite and staminate only, in loose mixed racemes: samara 1 in. diam., on an elongated stalk, 1 in., no distal notch.

**Celtis australis**, deciduous tree of NW. Himalya and S. Europe, cult.; flowers small, the hermaphrodite solitary or in pairs, axillary: fruit a drupe,  $\frac{1}{2}$  in., red or black, sweet.

**Trema orientalis**, a small short-lived tree of NW. Himalya, and cult.; coming up in clearings of damp forest: flowers mixed in axillary clusters; Fruit a small black drupe (4 mm.) with persistent per. segs.

**III.** **Moraceae** (55/900), a tree-series, with latex, the flowers small and aggregated into complex condensed cymose inflorescences which may end in taking on the mechanism for pollination. Individual florets then reduce to extreme limits, but the superior ovary retains two stigmas and one suspended anatropous ovule; fruits as minute achenes or drupes commonly become united in a succulent aggregated fruit-mass giving pseudocarps of very striking character and of economic value.

**Morus alba**, White Mulberry, a deciduous tree of W. and Central Asia, commonly cult. N. India, for silk-industry, and with Sissoo: flowers monoecious,

often on distinct branches; carpellary flowers with 4 per. seg.; in fruit these enlarge and enclose the drupe-fruit, becoming united in a succulent aggregated edible mass. Cf. *M. indica*, of E. and S. India, cult. for silkworm, fruits dark-purple.

**Broussonetia papyrifera** (Hort.) Paper-Mulberry, a small deciduous tree, Burma, dioecious; staminate flowers in pendulous catkins, 4 per. seg., and 4 inflexed stamens; carpellary inflorescence, spherical,  $\frac{1}{2}$  in., with closely aggregated perianths and elongated filiform pink stigmas. In fruit the inflorescence-receptacle enlarges, and the achenes hang out on fleshy stalks.

**Antiaris toxicaria** (= *Saccidora*) Upas Tree, an enormous tree (250 ft.) of evergreen forest, W. Ghats, &c., with buttressed stem, soft wood; flowers monoecious, the staminate on a mushroom-shaped receptacle (1 in. diam.) and sunk in depressions; stamens 3-8; carpellary flower solitary in leaf-axils, with involucre of bracts and 2 long styles: fruit drupaceous,  $\frac{3}{4}$  in.

**Artocarpus incisa**, Bread-fruit of Pacific Islands, cult. over Tropics: leaves large, deeply cut, flowers in massive inflorescences, much reduced; staminate system club-shaped, pendulous, with flowers reduced to 1 stamen in 2-4-lobed perianth: carpellary inflorescences sub-spherical, flowers sunk under convergent perianth-lobes, with ovary well below the surface, the elongated style, filiform, bilobed, and projecting at the surface. Fly-pollinated; in fruit the inflorescence forms a large spheroidal mass with starch-storage and smooth areolate surface, 6-10 in. diam.; seeds immersed.

**A. integrifolia**, Jack Fruit of W. Ghats, cult.; staminate inflorescence 2-6 in. long., fruit rough, with conoidal projections of enlarged perianth-segs. ( $\frac{1}{2}$  in.) for each flower, to size of large Marrow (30 in.): cf. also:—

*A. hirsuta*, timber-tree of evergreen forests of W. Ghats, to 200 ft.; staminate inflorescence slender, 3-4 in., ultimately pendulous; carpellary inflorescence 1 in. diam., in fruit 3-4 in., densely covered with hispid spines: seeds  $\frac{3}{4}$  in.

*A. Chaplasha*, a large deciduous tree of Sub-Himalya and S. Hill-forest, the globose pseudocarps, 3-4 in., edible, with few large seeds ( $\frac{1}{2}$  in.) taken by birds and monkeys. *A. Lakoocha* of Hill-forest, cult., fruit globose, irregularly lobed, with orange pulp and seeds  $\frac{1}{2}$  in., taken by monkeys and birds.

**Ficus** (600), the culminating genus of the series; inflorescence with declinous reduced flowers assuming a chamber-mechanism with narrow ostiole, through which small insects enter for pollination; in this way the inflorescence-cavity becomes a domicile, and the flowers are utilized by 'gall'-insects, eggs being laid in the ovaries of flowers specially adapted as 'gall'-flowers, the larva replacing the ovule.

In the simplest case (*Urostigma*-section) staminate flowers, carpellary, and gall-flowers are all mixed in the same chamber-system, which subsequently becomes a pseudocarp enclosing the small drupes of the individual flowers. Production is continuous, or becomes more or less seasonal in dry forest, and the generations of the insect are correlated with the production of flowers; 79 sp. Indian.

**Ficus bengalensis**, Bor (Banyan), of Sub-Himalya and S. India, greatly planted, to 100 ft. high, with descending aerial roots as 'props'; epiphytic as a seedling with descending roots to soil, growing freely from cuttings. Given time there seems to be no limit to lateral extension (assisted). Calcutta tree, seedling of 1782, 100 yds. diam. and 464 props, 1900. Nerbudda tree, covering nearly 1 sq. mile. Attaining great age, 2,200 yrs. recorded. Staminate flower of 1 stamen, carpellary with 1 stigma-lobe more pronounced. Fruit small, globose,  $\frac{1}{2}$ - $\frac{3}{4}$  in., scarlet when ripe. Host-trees become 'Ficus-bound'.

**F. religiosa**, Peepul, a large spreading tree of Sub-Himalya, much planted and growing from suckers. Tree of Budh-Gya from 500 B.C. Foliage like Poplar, tremulous, with long drip-tips, 1-2 in.; epiphytic or on buildings. Fruits  $\frac{1}{2}$  in. diam., dark purple.

**F. infectoria**, large deciduous tree of N. and Central India, figs small,  $\frac{1}{4}$  in.

**F. elastica**, India Rubber, gigantic evergreen tree, 100-150 ft. and crown to 200 ft. diam.: germination epiphytic, trunk buttressed, roots spreading on soil

(150 ft.) and anastomosing, aerial roots descending, leaves coriaceous, 1 ft. or more long : figs,  $\frac{1}{2}$  in., yellow, taken by birds.

*F. glomerata* of *Neomorphe*-section, with staminate flower of 2 stamens. A common large deciduous tree in ravines and damp places ; all types of flower in same receptacle, fruits nearly globose,  $1\frac{1}{2}$  in. diam., clustered on the leafless branches and spurs of older wood. Commonly full of insects ; taken by monkeys and deer.

*F. macrocarpa*, a climbing shrub of Hill-forest, with large fruits to  $2\frac{1}{2}$  in. diam., white spotted green, clustered on the old wood.

**F. Carica**, common Fig (*Eusyce*-section), more primitive in the individual flowers, but much further advanced in seasonal adaptation (the form farthest north) to a colder extra-tropical climate, with limiting case of insect-association and marked deciduous habit. A large tree of E. Medit. and W. Asia, cult., growing freely from cuttings, and fruiting as a shrub. Staminate flower with perianth of 5 teeth and stamens 5 (4-7) : carpellary flower with long style, 2 mm., and one stigmatic lobe rudimentary : Gall-flowers have styles of half the length, correlated with that of ovipositor of *Blastophaga* wasp. Fruits as minute drupes with sharply angular sclerosed 'stone'.

In Medit. region 3 crops of figs follow the annual succession, and 3 generations of gall-wasps. (1) Spring-crop (*Profichi*) of basal gall-flowers and staminate flowers produced later near the ostiole, borne on the old wood with the young leaves. (2) Summer crop on new growth, of few gall-flowers and mostly carpellary flowers, giving the edible fruit-crop. (3) Autumn set with gall-flowers and a few carpellary. The 3 crops act practically as staminate, carpellary fruiting, and a perennating stock, respectively. Only cross-fertilized figs of (2) give good commercial 'figs' with fertile seeds. Seedlings come up as 'Wild Figs' with *Profichi* fruit. Cuttings of *Profichi*-branches remain as staminate 'Caprifigs', used for pollination. Cuttings of fruiting figs (= var. *domestica*) cult. in this country, without *Blastophaga*, give inferior but edible pseudocarps without seeds.

**CUPULIFERAE** (*Gen. Plant.*, 1880), include families of Monochlamydeous series with reduced flowers (tending to trimery, dimery, dicliny, and anemophily), with inflorescences more or less of catkin-habit and characteristic protective investments of the developing fruit as 'cupules', &c. (Fagaceae, Betulaceae). With these may be associated other stray residual series distinguished by different modes of ovary-organization (superior or inferior, with axile, parietal, or basal placentation)—Juglandaceae, Salicaceae—all with representatives in the British Flora, as also tropical Casuarinaceae. Any evidence of a former petaloid state is wholly wanting.

**I. Betulaceae**, flowers in catkins, monoecious, dimerous; carpellary flower with ovary of 2 carpels, each loculus 1 ovule: fruit a nut with 1 seed, retaining traces of endosperm, and storing fat: subtending bracts and prophylls more or less retained as protective investment of fruit; cf. *Betula*, *Alnus*, *Corylus*, *Carpinus*, *Ostrya* of N. Temp., with representative sp. in Himalya at 2 miles elevation—*Betula utilis* at the limit of trees; *Alnus nitida*, a large tree at lower elevations, and *Carpinus viminea* near streams.

**Corylus Columna**, a moderate-sized deciduous tree of NW. Himalya, often gregarious; staminate catkins abundant, pendulous, 4 in.; fruits in large clusters with lacinate cupule-involucre, enclosing small nuts with thick shells.

**II. Fagaceae**: Flowers monoecious, trimerous; carpellary flower with 3 (6) carpels, axile placentation, 2 ovules per loculus; fruit a nut, 1-seeded, without endosperm, cotyledons store starch—cf. *Quercus*, *Fagus*, *Castanea* of N. Temp. flora. *Fagus* does not occur, and *Castanea* only as introduction. *Quercus* is at its optimum in Hill-forest, 37 sp.; cf. NW. Himalyan types:—

**Quercus incana**, White Oak, Ban, gregarious in NW. Himalya at 4,000–8,000 ft. (Simla level), with *Rhododendron*, *Deodar* and *Pinus*. A large evergreen tree, 60–80 ft., dull-green leaves, coriaceous, serrated, and white below, 3–6 in.; Acorns solitary or in pairs, 1 in. long, ovoid, conical, pointed, in small rough woody cupule, fruiting 15 months from flowering, and so borne on previous season's wood.

**Q. dilatata**, Green Oak, Moru, at elevations of 7,000–9,000 ft. (English level), semi-gregarious, in ravines with *Picea Morinda*, &c.; Leaves coriaceous, shining, serrations jagged and pointed, nearly evergreen. Fruits, pointed, 1 in., nearly sessile, in normal cupule,  $\frac{1}{2}$  in. diam.; Fruiting 15–17 months after flowering.

**Q. semecarpifolia**, Brown Oak, Kharshu, more deciduous; older leaves entire, 2–4 in., coriaceous, brown underneath, gregarious in upper zone of 8,000–12,000 ft. (Alpine level) with Birch, Yew, &c.; staminate catkins in bunches, 2–6 in. long; fruits solitary, taking 15 months, 1 in. diam., black, with rounded end, in thin shallow cups with pointed scales. Cf. also of special interest:—

**Q. lamellosa**, Buk, of E. Himalya (Darjeeling), 100–120 ft.; acorns 2–3 in. diam., almost immersed in woody cupule, with about 10 concentric lamellar ring-growths.

**Q. Griffithii** of Assam and Burma, a large deciduous and gregarious tree, acorn more cylindrical, on short spikes; also with remarkable scaly galls, to 1½ in.

**Q. spicata**, *Pasania*-type, a large evergreen tree, with shining leaves of *Castanea*-type; staminate catkins erect, in long paniced systems, to 8 in.; carpellary systems with many triads (30); in fruit to a foot long, with to 100 shining acorns, cup  $\frac{1}{2}$ –1 in. diam. As extreme case cf.:

**Q. magnifica**, in evergreen forest of Shan States, woody cupule  $\frac{1}{8}$  in. thick, and acorn woody,  $\frac{1}{8}$  in. thick wall, and lobed cotyledons.

**Castanopsis tribuloides**, evergreen tree of E. Himalya and Hill-forest, more or less gregarious; leaves coriaceous, entire; staminate catkins erect, in terminal systems, in the manner of *Castanea*; carpellary catkin with numerous triads, each with spinous cupule of *Castanea* type; in fruit to 10 in. long, with many burr-cupules,

1 in. diam., spines long ( $\frac{1}{2}$  in.) and stellately branched; included nuts, 2-3, cotyledons ruminated.

**Juglandaceae** (6/33) representative of a wholly isolated series, based on *Juglans regia*, Walnut, indigenous to Himalya and E. Europe, cult.; deciduous and monoecious: staminate flowers in racemose catkins from last season's wood: carpellary systems few-flowered; perianth 2 + 2, carpels (stigmas) 2, ovary inferior, with 1 basal ovule centred and orthotropous. Fruit drupaceous, with remarkably lobed embryo, moulded to the shape of 4 diagonal tracts in the ovary-wall, storing fat. Sclerocarp of fruit with traces of loculicidal dehiscence (two shells), very hard in the wild form.

**Engelhardtia spicata**, a large tree often gregarious in Hill-districts, leaves compound; staminate flowers in slender catkins, 3-7 in. long; carpellary systems pendulous, 6-12 in., with densely papillose stigmatic branches. Bract and prophylls as involucre above inferior ovary. Fruit a small 1-seeded nut, with lobed cotyledons to seed. The involucre grows to a 3-lobed leafy expansion (suggestive of *Carpinus*), the middle lobe ( $\beta$ )  $1\frac{1}{4}$  in. long, as a spinning 'wing'.

**Salicaceae** (2/200) including only *Salix* and *Populus* with representative species of characteristic appearance and habit. Common British forms also as introductions.

**Salix tetrasperma**, the common type, general along river-beds, often gregarious: staminate catkins after the leaves, 2-4 in. long; flowers with 5-10 stamens; carpellary catkins 3-5 in.; fruits with few (4-6) seeds.

*S. babylonica*, Weeping Willow, indig. to China, cult. in N., staminate tree commoner.

**Populus ciliata**, common in NW. Himalya, typical Poplar-habit, at 1-2 miles elevation, a tall deciduous tree with viscid buds exuding balsam, leaves cordate, finely ciliate; carpellary catkin 6-12 in. long, ovary with 3-4 carpels (rarely 2).

**P. euphratica**, gregarious in Sind, over Tamarisk, and by rivers; leaves very variable in shape and lobing; staminate flower with 8-10 stamens; capsule commonly of 3 carpels, to  $\frac{1}{2}$  in.

**Casuarinaceae** (1/25) a monotypic genus of halophytic tropical trees with no functional leaves: Shoot-systems Equisetoid, with the appearance of a Conifer: Assimilatory ridged stems with whorls of scales (6-15), end-ramuli shed as phyllo-morphs. Flowers reduced to extreme limits: staminate flowers of 1 stamen, in whorled series, resembling erect catkins: carpellary flowers similarly whorled, in axil of bract, with prophylls ( $\alpha$  and  $\beta$ ) as protective involucre. Gynoecium of 2 carpels (bilobed stigma), unilocular ovary with 2 superposed ovules: fertilization chalazogamic, also the ovules develop large numbers of megaspores, many with prothallial mechanism, but only one seed sets. The prophylls when sclerosed give a woody whorled cone-like aggregate, and the ovary with median wing-extension to the style is a small samaroid nut (spinning). The enclosed seed has no endosperm. (Often regarded as a primitive, if not the most 'primitive' Angiosperm, and hence often at the beginning of the classification (Engler, Dicots., 1912).)

**Casuarina equisetifolia**, a tall tree, 100 ft. or more, of sand-hills and strand-forest throughout Malay and S. India, to tide-level, cult. and planted. Photosynthetic ramuli 6-8-ridged and furrowed: monoecious, cones small,  $\frac{3}{4}$  in., cylindrical with about 60 fruits; seed with stylar wing 6 mm.

**Santalaceae** (26/250), an order of essentially tropical trees with few representatives in N. Temp. (*Thesium*, herbaceous). Flowers, small, hermaphrodite, apetalous, 5-4-merous: perianth may be gamophyllous and tubular, the ovary inferior, with basal placenta bearing 1 or more ovules without integuments; Fruit 1-seeded: many are hemi- or holo-parasitic.

**Santalum album**, Sandalwood, a small evergreen tree (40-50 ft.) of S. India, cult., gregarious in scrub-forest in Mysore, hemiparasitic on roots of adjacent plants: leaves opposite, flowers brownish-purple in small axillary and terminal panicles,

4-merous; stamens 4, alternating with lobed outgrowths of receptacle-cup; ovary with central placenta filling cavity, and rudimentary ovules. Fruit a small drupe,  $\frac{1}{2}$  in. diam., with hard 1-seeded sclerocarp, taken by birds.

**Loranthaceae** (21/850), a group of hemiparasitic shrubs of tropical forest (*Nuytsia* of W. Australia, 30 ft., non-parasitic), leaves opposite, flowers trimerous, in dichasial or triad-systems. Full type 3 + 3 perianth, 3 + 3 stamens, and gynoecium of 3 carpels, but so reduced that there is now no ovary-cavity or ovules; the embryo-sacs arise in the fused parenchymatous tissue, or the cavity is indicated by mere slits following the case of *Santalum*. The fruits specialize as bird-distributed 'berries', the seeds being represented by masses of endosperm with included embryos: cf. indig. *Viscum album* (Mistletoe) as last northern stray, and *Loranthus*, 300.

**Loranthus longiflorus**, commonest Indian form, a large parasitic bush on Sal, Mango, and even Chir. Leaves broad and coriaceous, flowers in unilateral racemes, perianth-tube to  $2\frac{1}{2}$  in. long, slightly curved, scarlet or orange, bird-pollinated, with 5 free segments reflexed; filaments inserted on perianth-tube, with anthers projecting, style 55 mm., to the level of the anthers; Berry oblong with viscid pulp,  $\frac{1}{2}$  in., bird-dispersed in the manner of Mistletoe. *Viscum album* common on Olive and *Quercus Ilex* in NW. hill-forest, dioecious and fly-pollinated.

**Arceuthobium minutissimum**, a minute parasite on *Pinus excelsa*, shoots articulated, green, almost moss-like,  $\frac{1}{4}$  in.; another extreme case of reduction, dioecious; staminate flower with monotheic anthers on segments of perianth (4-5), the carpellary flowers only just emerging from the bark. The smallest Dicot. plant.

**Proteaceae** (50/1100), a remarkably isolated family (Proteales, Engler, 1912) of trees and shrubs, characteristic in S. Hemisphere (Australia, S. Africa), a few extending North (*Helicia*) of Malay and S. India, *H. lancifolia*, S. Japan, the farthest North. Flowers of very uniform organization, very distinctive, usually 4-merous, with 4 stamens carried upon individual zones of growth with superposed perianth-segs., and so appearing 'inserted' on them. Gynoecium of a single superior carpel (and so far an ancient apocarpous series), with many, few, or 1 ovule. The plants commonly present extreme xeromorphic adaptations; the flowers may be highly conspicuous and bird-pollinated, the fruits massive woody pods.

**Grevillea robusta**, Silky Oak of E. Australia, cult., a large tree with compound leaves, bipinnately segmented. Flowers golden-yellow in clustered racemes (3-4 in.) on short spur-shoots. Fruit a coriaceous follicle,  $\frac{3}{4}$  in., with 1-2 seeds.



**MONOCOTYLEDONS**, a large section of Angiosperms collateral with modern Dicots., convergent only in retention of an older phase of Monochlamydeous state of floral organization, and comprising a large number of widely divergent series expressing most advanced phases of specialization in some respects, and of further reductions in others, in somatic organization as well as in floral construction. The tree-phyta (Palms) have no cambial increase of timber, and the stems are predominantly *monaxial*; but this is counterbalanced by the immense size of the foliage-leaves, and freely-branched inflorescence-systems. All tend to the limiting condition of a trimerous eucyclic type of flower—passing to extreme phases of reduction in anemophilous inflorescence-aggregates (Grasses), or to the extreme elaboration of individual entomophilous floral mechanisms (Orchids). The single cotyledon of the seedling, indicated as characteristic of the class as a whole, is comparable with the single posterior 2-keeled prophyll of the vegetative laterals in many types, as a specialized gamophyllous structure replacing two initial primordia.

**I. Palmae** (128/1000), typically monaxial arboreal forms, with leaf-lamina secondary on a hooded petiolate scale-base, plaited fan-wise and segmented by the decay of strips of surface-tissue (palmate-type), to be subsequently elongated on a rachis-growth (pinnate-type). Wholly entire leaves occur (*Corypha*; King Palm, and juvenile states); bipinnation in *Caryota*; basal pinnules are commonly spinous, subserving xerophytic bud-protection of the apex; the leaves spirally arranged, with persistent leaf-bases (similarly protective), or abstricted with clean annular scars.

*Inflorescence-systems*, terminal or axillary, retain older more generalized ramification-schemes, to multibranched panicles (30 ft.) with thousands of flowers (to 600,000), or reduce to cymose systems on condensed spadix-growths: large protective bracts of leaf-base construction (spathes) may subserve protection of younger parts or developing fruits.

The growth-period is often monocarpic with T-paricle. Lianoid forms present extended internodes (*Calamus*) with spiny 'lora' as leaf-rachis or inflorescence-axis. The monaxial stem may reduce to a rosette-habit, with crown of fronds in the manner of a Cycad (*Phoenix acaulis*) or may become rhizomatous at the surface or subterranean in the manner of advanced ferns (*Nipa*, swamp-type, *Nannorhops*, desert xerophyte).

*Flowers*, trimerous, and commonly much reduced, tending to dioecy with limit in dioecism, fundamentally of eucyclic type, per. 3 + 3, and. 3 + 3, gyn. 3, apocarpous to typically syncarpous, with floral output reduced to 1 seed per loculus, and commonly restricted to 1 seed per flower in a berry or drupaceous fruit. The seeds store fat in endosperm-tissue, or celluloses in its walls, the endosperm simple, incomplete with cavity, or 'ruminated'. The stems may store large reserves of starch. Xeromorphic specializations of all kinds commonly prevail in all vegetative and reproductive parts. The range of type in such an isolated series is so great that classification by one character more than another is wholly empirical. Forms with older palmate leaves seem more archaic on the whole, as comparatively few and residual, though advanced in other respects. The family is essentially tropical of moist regions but may range to dry tracts (*Nannorhops*) with external xeromorphic details. *Chamaecrops humilis*, a bushy form, 20 ft., alone extends to Europe (with *Phoenix* as introduction in Greece, &c.). Hardy Chinese forms will flower in the open in S. of England.

**Phoenix dactylifera**, Date Palm of SW. Asia and Sahara, to 120 ft., monaxial with pinnate foliage (7-12 ft.), stem clothed with old leaf-bases, dioecious. Inflorescence much branched, axillary; staminate flower with 6 stamens; carpellary flower of 3 + 3 perianth, inner series protective, 5 mm., and 3 carpels, apocarpous with distinct stigmas. Fruit as 3 berries, 1-3 in., each with 1 elongated seed (1 in.);

the small embryo half-way along the seed, and the endosperm horny with thick cellulose walls. Cult. in vars. and propagated by suckers.

**P. sylvestris** of India, on low ground and along river-banks, gregarious and cult., tapped; 40 ft., similar in habit, leaves 7-15 ft., fruit 1 in.

**P. acaulis** common in forests of Sal, Chir, and Eng. Stem an ovoid tuber.

**Chamaerops humilis**, a bushy form, 20 ft., with palmate leaves, stout stem and tufted growth; the gynoeceum of 3 carpels slightly cohering below, each with stigma, only one set seed. As great monocarpic type cf.:—

**Corypha umbraculifera**, Talipot Palm, Ceylon and S. India, cult., to 80 ft., and  $2\frac{1}{2}$  ft. diam. annulate, growing 17-40 years, leaves 8-16 ft. diam., palmate, cut in 80-100 segments, 6 in. wide, and halfway down. Terminal panicle 10-20 ft., pyramidal; flowers hermaphrodite, ovary 3-lobed, 3-locular; Fruit of 1 carpel-lobe,  $1\frac{1}{2}$  in. diam., drupaceous, globose; seed 18 mm., with small embryo in horny uniform endosperm with thick cellulose walls; output  $\frac{1}{4}$  ton of seeds.

**C. Taliera**, representative sp. in Bengal, leaves cut less than half-way down.

**Borassus flabellifer**, Palmyra Palm of Trop. Africa, cult., to 100 ft. and 2 ft. diam., annulate; leaves on long stalks, palmate, 3-5 ft. diam., cut in 60-80 segments. Dioecious, inflorescence of massive ramuli (spadices) with close-set bract-scales and the staminate flowers in small cymose clusters, immersed under scales and emerging one at a time to function: carpellary flowers large (1 in.) immersed, the stigmas alone protruding, ovary with separate loculi. Fruit a massive fibrous drupe, 6 in. diam., with 3 large pyrenae in sarcocarp-pulp; seed incompletely filled with horny endosperm.

**Lodoicea Seychellarum**, Double Coconut, monotype of Seychelles Is., to 120 ft., palmate leaves, socket-base, dioecious: staminate spadix, 3 ft., flowering continuously for several years: carpellary flower 3-4 in. diam.; Fruit a fibrous drupe, full size in 4 years, mature in 7-10, seed  $1\frac{1}{2}$  ft. long; fruit 40 lb. weight, in clusters of 4-11: endosperm  $\frac{1}{2}$  in. deep, solid.

**Cocos nucifera**, Coconut, Polynesia, cult.; Stem smooth, annulate, to 80 ft., leaves pinnate, 6-12 ft., leaflets 2-3 ft., monoecious, with stout spadix (4-6 ft.) with drooping branches; staminate flowers numerous in upper branches, 10 mm., 3 outer per. seg. large and coriaceous, stamens 3+3: carpellary flowers few, at base of spadix-branches, 1 in., with massive perianth-segs. and ovary syncarpous, 3-locular. Fruit a large 3-angled fibrous drupe (1 ft.): sclerocarp with 3 basal pores to ovary-loculi, 'eyes', one non-sclerosed. Seed 5 in. long, ovoid; endosperm white, storing fat,  $\frac{1}{2}$  in. deep (copra), cavity of seed subserving flotation, embryo imbedded opposite soft 'eye', conoidal,  $\frac{1}{2}$  in.: fruits take a year to mature; a tree produces 50-100 nuts a year.

**Elaeis guineensis**, Oil Palm of Trop. Africa, cult. in Tropics in vars., to 100 ft., with pinnate foliage and stem clothed with spinous leaf-bases; more or less dioecious; staminate inflorescence an aggregate of cylindrical spikes, flower with 6 stamens on a 'column'; carpellary system of cone-like spiral aggregates, giving clusters of fruits the size of a walnut, with oil in sarcocarp; sclerocarp with 3 'eyes', one functional, 10 mm.; seed with white fatty endosperm.

**Calamus tenuis**, Canes, of Sub-Himalya, in damp forest, stems slender, 5 mm., forming cane-brakes, leaves pinnate, 1-2 ft., with thorny flagellum of modified leaflets and inflorescence bracts; monoecious, staminate flowers small, in spikelets; carpellary flower with scales in symmetrical pattern (suggestive of phyllotaxis) on massive ovary with plumose stigmas. In fruit ( $\frac{1}{2}$  in.) the scales clothe the outer straw-coloured surface imbricating downwards; seed 1, with horny endosperm.

**C. Rotang** of S. India, very similar; other sp. (200) may be powerful climbers, 100-400 ft., with characteristic habit, leaf-rachis 'lora', and similar flowers and fruit. Cf. large brown polished scalyfruits of *Raphia Ruffia* (Sago Palm of E. Africa),  $2\frac{1}{2}$  in., borne on distichous ramuli.

**Caryota urens**, Mhar Palm, in evergreen forest of W. Ghats, and Hill forests

of E., to 50 ft., with bipinnate frondose leaves, to 20 ft. by 10, with cuneate segments, monocarpic: terminal inflorescence, 10-12 ft., flowers first, and laterals in sequence to extreme base of stem, with long and slender tassel-ramuli. Flowers in triads, carpellary T and staminate T'; the latter with numerous stamens (40-45); carpellary flower sub-globose, ovary 3-locular. Fruit globose,  $\frac{3}{4}$  in., with 1 (2) seeds, endosperm hard and ruminated.

**Areca Catechu**, Betel-Nut Palm, cult.; to 100 ft., with smooth annulate stem, 6-9 in. diam.; leaves pinnate, 4-6 ft. Inflorescence below the leaves, monoecious, branched; staminate flowers at end of ramuli, small, normal; carpellary flowers at base of ramuli; ovary syncarpous, unilocular, with 3 stigmas, and 1 basal erect ovule. Fruit a fibrous scarlet drupe, 2 in. long. Seeds 1 in., sub-globular, with beautifully ruminated endosperm, thick cellulose walls and fat-storage.

**Arenga sacchifera**, Malay Sago-Palm, cult.; Monocarpic: stem 24-40 ft., densely clothed with fibrous remains of leaf-bases, leaves 20-28 ft., pinnate, in dense crown. Inflorescence much branched, 6-10 ft., with pendulous laterals; lateral systems function basipetally, flowers commonly in triads with carpellary T. Staminate flowers 1 in. long, with numerous stamens; carpellary flower 1 in. diam., ovary 3-locular; Fruit 2 in., seeds 2-3, compressed, endosperm simple. Starch-storage in main axis (sago), spadix tapped for sugar (toddy).

**Nipa fruticans**, estuarine and halophytic in all Trop. Asia, giving *Nipa*-zone on mud-banks of tidal estuaries. Stem a branched, creeping, rhizome, rooting below, with crowns of pinnate fronds, 15-30 ft.; leaflets coriaceous, 2-4 ft.: Flowers monoecious, in packed spicate systems. Staminate flowers in cylindrical spikes, perianth segs, 3+3, stamens 3 on a column: carpellary flowers on a globose head, 3 carpels distinct, 1-seeded. In fruit the whole enlarges to a globose aggregate, 1 ft. diam., of angular drupes, with surface-facets, sclerocarp fibrous-fleshy; the seeds 2-3 in., with horny endosperm and central cavity.

Cf. *Phytelephas* of Trop. Amer., Vegetable-Ivory, for very parallel ecological type.

**II. Pandanaceae** (2/220) including comparable phases of extreme reduction-specialization, as arboreal forms with monaxial or branched habit, climbing or rhizomatous, of estuarine and tidal swamp-forest, with stilt-roots, leaves coriaceous, linear, in 3 'spires' (Screw-Pines). Commonly regarded (since apocarpous and destitute of perianth as extremely archaic, and placed on a level with indigenous *Spartanium* and *Typha* (Engler, 1886); more probably convergent only in adaptation to swamp-habit.)

**Pandanus tectorius** (= *odoratissimus*), of coast-forest, gregarious, as a zone above high-water, and much cult.; Stems to 25 ft. on strong stilt-roots; leaves 3-5 ft. spinous on edges; dioecious; inflorescence terminal or axillary; staminate with pendulous ramuli and flowers clustered, without perianth, of numerous stamens on a 'column', in axils of white, fragrant, sheathing bracts. Carpellary flower of 4-12 closely aggregated carpels, each with 1 ovule. In fruit the entire system fuses to a massive drooping 'syncarpium' of scarlet drupes, each several-seeded within a common sclerocarp.

**GRAMINEAE** (314/4000), a great series of anemophilous Monocots, of specialized habit, essentially rhizomatous, convergent with Palms in arboreal examples (Bambuseae), but more characteristically reduced to herbaceous habit and prairie-land formation. The essential departure of the grass-type centres in loss of the erect main (primary) axis, and substitution of a perennial shoot-system at the ground-level, or below, sending up erect slender shoots (culms) of seasonal habit, with greatly extended internodes and distichous leaf-arrangement, with telescopic growth-effect. Rarely monaxial (by culture) *Zea*, or annual (cult. cereals). The leaves are simple, with sheathing base, ligular vestige of primary apex, and secondary linear lamina-extension with parallel venation. The inflorescence is freely paniced, with many grades of reduction-specialization; the flowers on ultimate ramuli reduce their perianth-segments in correlation with aggregation to special 'spikelet' inflorescence-units, of distichous construction, in which the subtending bract (lower pale) and 2-keeled posterior prophyll (upper pale) acquire a special protective value, and the limiting contact-cycle of 2 'sterile glumes' constitutes an additional involucre to the system. In the limit the flowers of a spikelet may reduce to 1 only. The general scheme attained is remarkably uniform; herbaceous types of the N. Temp. express limiting cases of reduction-specialization in connexion with xerophytic prairie-conditions and adaptation to a short season.

As extreme examples of divergent lines in tropical regions, cf. :—

**I. Bambusa**, Bamboo, 50, with associated genera (13) distinguished by special details of flower and fruit. The typical primary grass of tropical forest-formation, arboreal and gregarious, as nearer the prototype of the family. Woody culms to 100 ft. are shot up in a month of the wet season, with branching heads of distichous foliage and branching panicles of flowers; the latter hermaphrodite, with full spikelets, normal glumes and pales, vestigial perianth of 3 segments, 6 stamens (3+3), and ovary with 3 free stigmatic plumes, unilocular with one anatropous ovule on the posterior side (against rachis). The fruit is a dry caryopsis with endosperm storing starch, and is shed as 'free' grain.

**II. Zea Mais**, expressing an advanced type of cereal, as a special limiting case of tropical cultivation, is an artificial strain of *Euchlaena mexicana*. Now monaxial, monocarpic, annual, declinous; to 12-15 ft., the vegetative branching of *Euchlaena* superseded: staminate flowers in a branched terminal distichous panicle, the spikelets 2-flowered and in pairs (T and T'), stamens 3, with normal glumes and pales. Carpellary flowers in lateral systems, reduced to massive axis with high whorled phyllotaxis (4-8), spikelets paired and 2-flowered, but one merely a rudiment; ovary with large ovule and single style-filament, to 6 in. long (collecting 'silks' of young 'cob'). Fruit as naked grain, not detached, growth of pales and formerly protective glume suppressed; seed large, confluent with ovary-wall; endosperm solid with packed starch: cult. in many vars.

**III. Saccharum officinarum**, Sugar-cane, cult. in Tropics to S. Europe; 6-12 ft. high and 2 in. diam.; herbaceous type of seasonal savannah. Stem annulate, with short internodes (3-6 in.); panicle terminal, 1-2 ft., pyramidal, plumose, multi-branched; spikelets on end-ramuli paired (sessile and stalked, T and T'), 1-flowered, no awns but the glumes densely hairy; stamens 3, stigmas 2, lodicules functional: seed enclosed in pales, spikelet abstricted, and dispersal by aid of tufted glumes. A non-flowering var. cult.

**IV. Oryza sativa**, Rice, Swamp-type, of E. Asia, the oldest food-grain, cult. in vars.: a much reduced form, 2-3 ft., with small panicle, 6 in., spikelets reduced to 1 flower, glumes small, pale awned (or not), stamens 3+3, stigmas 2, lodicules present. Spikelet detached in fruit, with seed enclosed in folded bristly pale (8 mm.) with awn, 8 mm. Endosperm solid with packed starch.

As Indian Bamboos, cf. :—

**Bambusa Tulda**, common Bamboo of N. India on alluvial flats by streams, gregarious, cult., flowering casually; culms densely tufted, 20-70 ft., internodes 1-2 ft., and 2-4 in. diam.; sheaths 6-9 in. long, investing and guiding the young growth: foliage-lamina 6-10 in. by 1. Flowering-culms leafless, producing an immense multibranched panicle; spikelets clustered, 1-3 in. long, with 4-6 fertile flowers; stamens 3+3, anthers exerted, purple, stigmas 3; fruit (caryopsis) 8 mm. long, grooved on one side, shed 'clean' from pales.

**B. arundinacea**, Thorny Bamboo of Cent. India, cult., gregarious in moist deciduous forest, and by streams, monocarpic: culms 50-120 ft., internodes 12-18 in., and 6-7 diam., walls thick (1-2 in.); leaves small and thin (8 in.). Large leafy branches bending over, and branchlets with sharp spines at nodes, entangled: spikelets sessile, 1 in., 6 stamens and 3 long plumose stigmas. Culms flower out gregariously.

**B. polymorpha** of damp deciduous forest, and gregarious with Teak in Burma; tufted culms 60-80 ft., internodes 12-30 in. and 3-6 diam. with relatively thin walls. Tops branched, gracefully bent, with branches in 'half-whorls': foliage-leaves 4-6 in., spikelets sessile, clustered,  $\frac{1}{2}$  in.; Fertile flowers 3, with several empty glumes. Monocarpic, flowering out gregariously at long intervals (60 years).

**Dendrocalamus strictus**, 'Male Bamboo', commonest and hardiest of Indian sp., in dry deciduous forest, with Teak (Myinwa). Culms 20-50 ft. high, and 2-3 in. diam., or 1 in. and solid in dry regions: leaves 4-10 in., linear: Inflorescence a distinct xeromorphic type; spikelets hairy in globose stellate heads, 1 in. diam., with hard-tipped glumes, 'empty' glumes, numerous and assisting protection, fertile flowers 2-3: stamens 3+3, no lodicules, and 1 hairy elongated stigma. Caryopsis enclosed in hard pale-sheath; flowering casually or gregariously.

**D. Hamiltoni**, culms to 80 ft. and 6-7 in diam., arcuate in dense thickets, Burma, and cult., flowering sporadically; flower capitula semi-globose,  $1\frac{1}{2}$  in. Conspicuous eye-like marks on lower nodes from suppressed buds.

**D. giganteus**, of Burma, Wabo, the largest stem; densely tufted, culms to 100 ft. and 8-12 in. diam., wall  $\frac{1}{2}$  in. thick. Spikelets  $\frac{1}{2}$  in., 2-5 in aggregate, on long spikes, spaced about  $\frac{1}{2}$  in.

**Cephalostachyum pergracile**, Tinwa, commonest Bamboo of Burma: tufted culms 30-40 ft., 2-3 in. diam., leaves 6-14 in.; flowering gregariously; Inflorescence of small globose heads, spaced at 2-3 in. on wiry ramuli of a large leafless panicle: spikelets with many empty glumes and few fruits.

**Melocanna bambusoides** the most aberrant form, gregarious, Arakan: Culms distant, from vigorous rhizome extending laterally, 40-70 ft. high, 1-3 in. diam., bare below; panicle 3 ft. and spikelets fasciated at the nodes, more or less declinuous, stamens 3+3. Monocarpic, flowering out at intervals of 30 years or so, for hundreds of sq. miles; the characteristic fruit increases to the size of an inverted pear, 3-4 in., with long pointed beak; the massive wall stores starch, without special protective mechanism or vitality, the single large seed,  $\frac{3}{4}$  in., has no endosperm, but a massive scutellum to the small 'embryo'-region. On germination the scutellum digests directly from the ovary-wall.

---

**GYMNOSPERMS: I. Coniferae—Pinoids**, restricted to representative species of N. Temp. genera in Himalya and Hill-forest.

**Pinus excelsa**, Blue Himalyan Pine, gregarious at 6-12,000 ft., to 100-150 ft. high, cones 6-12 in., in groups of 2-5, with soft scales and terminal umbo of *P. Strobis* type; cones ripened in second season. Five-needled.

**P. longifolia**, Chir, gregarious in outer Himalya at 1,500-3,000 ft.; cones large and massive, 6-8 in., with hooked apophyses, ripened in second season: leaves slender and pendulous, to 18 in. Three-needled.

Also cf. *P. Khasya*, gregarious in Burma, cones 2-3 in.; *P. Gerardiana* of NW.

Himalya, 3-needled, cones massive, 6-9 in., seed-wing inefficient; *P. Merkusii*, Burma, to 100 ft. and 5 ft. diam., cones 2-3 in., two-needled, associated with Eng and *Pentacme*, as showing possibilities of the genus.

*Cedrus Deodara*, gregarious in W. Himalya, at 4-10,000 ft. in damp forests on outer ranges, to 240 ft. and 10 ft. diam.; end-branches drooping, flexuous; foliage dark-green, needles 1 in., on tufted spurs; cones woody, 4-5 in.; flowering in Sept. Oct., and ripening cones in 12-13 months.

*Abies Pindrow*, a tall tree, 200-250 ft., feathered to base, of low-level forests of W. Himalya; branches drooping, needles 2-3 in.; cones 4-7 in. erected, violet-black, without projecting bract-scales.

*Picea Morinda*, a tall tree of NW. Himalya, 100-200 ft., with peculiar pendulous ramuli, 1-3 ft., needles 1-1½ in.; cones large, cylindrical, 6-8 in., pendulous, broad brown scales with thin rounded margin.

*Tsuga Brunoniana*, to 120 ft. and 9 ft. diam., gregarious Central and E. Himalya; leaves ½-1 in., pectinated, cones ¾ in.

*Larix Griffithii*, E. Himalya, at 2 miles elevation, deciduous, branches long and pendulous, foliage pale-green, cones 2-3 in. long with reflexed bract-scale.

*Cupressus torulosa*, semigregarious in outer ranges of NW. Himalya, a large tree with horizontal branches; cones ½ in., ripened in second season.

*Juniperus macropoda*, gregarious on dry ranges, a small tree, 50-80 ft., with dimorphic foliage; berries blue-black, ¼ in., resinous, taken by birds.

**II. Coniferae—Taxoids:** the only Conifer in the W. peninsula is *Podocarpus latifolia*, Hills of S. India, a large tree with fine leaves, 4-7 in. by 1-2 in., pectinated in 2 rows, and appearing opposite, with effect of pinnate foliage: seed ¾ in. globular, purple, succulent, erected on elongated succulent axis (1 in.).

*Taxus baccata*, in shady ravines of Himalya, at 2 miles elevation, and Hills of Burma, shows range of this ancient type.

**III. Cycadaceae**, with monaxial palm-habit, and crown of pinnate foliage-leaves. *Cycas*-type alone represented, 5 sp.

*Cycas circinalis* moist forests of S. India, 15-40 ft., and 100 yrs.; stem with leaf-scars, foliage-leaves 5-9 ft., pinnules flat. Staminate cone 1-2 ft.; Carpels on the main axis, to 1 ft. long, with 6-12 ovules. Seeds 1 in., yellow-red sarcotesta; endosperm storing starch.

*C. revoluta* of Japan, commonly cult., stem 6 ft. with old leaf-bases, leaves pinnate, 2-6 ft., margins revolute; carpels 4-9 in. long, with 4-6 ovules: cf. *C. siamensis* in Eng forest, carpels with 2 basal ovules. *C. Rumphii* of beach-forest, Coco islands, may give 50 ft. shaft and 18 in. diam., seeds 2-3 in. long. Interest botanical rather than silvicultural.

While the Cycads with the specialized monaxial habit of Tree-Ferns and Palms can never have been the precursors of modern Angiospermous trees, special interest attaches to *Gnetales*; less to *Ephedra* with reduced foliage and photosynthetic ramuli than to *Gnetum*, species of which still remain in the form of lianoid types in the original station of Tropical forest: cf.—

*Gnetum scandens*, an immense evergreen climber of Hill-forest of S. India and Burma, trunk 9-12 in. broad, flattened, with anomalous vascular structure; leaves decussate, broad, net-veined; flowers, dioecious, whorled, in clustered catkin-like systems, 2 in.: Seed, 1 in., drupe-like with edible orange-coloured 'sarcotesta'.



# OXFORD BOTANICAL MEMOIRS

---

Edited by A. H. CHURCH, M.A.

1. **THE BUILDING OF AN AUTOTROPHIC FLAGELLATE**, by A. H. CHURCH. 1919. Pp. 27 (*out of print*). 2s. net.
2. **GOSSYPIUM IN PRE-LINNAEAN LITERATURE**, by H. J. DENHAM, M.A. 1919. Pp. 24, 4 text figs. 2s. net.
3. **THALASSIOPHYTA AND THE SUBAERIAL TRANSMIGRATION**, by A. H. CHURCH. 1919. Pp. 95. 3s. 6d. net.
4. **ELEMENTARY NOTES ON STRUCTURAL BOTANY**, by A. H. CHURCH. 1919. 12 Lecture-schedules. Pp. 27. 2s. net.
5. **ELEMENTARY NOTES ON THE REPRODUCTION OF ANGIOSPERMS**, by A. H. CHURCH. 1919. 10 Lecture-schedules. Pp. 24. 2s. net.
6. **ON THE INTERPRETATION OF PHENOMENA OF PHYLLOTAXIS**, by A. H. CHURCH. 1920. Pp. 58, 18 figs. 3s. 6d. net.
7. **ELEMENTARY NOTES ON THE MORPHOLOGY OF FUNGI**, by A. H. CHURCH. 1920. 13 Lecture-schedules. Pp. 29. 2s. net.
8. **ELEMENTARY NOTES ON CONIFERS**, by A. H. CHURCH. 1920. Fifteen Lecture and Laboratory Schedules. Pp. 32. 2s. net.
9. **FORM-FACTORS IN CONIFERAE**, by A. H. CHURCH. 1920. Arranged as Supplement to preceding. Pp. 28. 2s. net.
10. **THE SOMATIC ORGANIZATION OF THE PHAEOPHYCEAE**; an Introduction to the Theory of the Plant-soma, by A. H. CHURCH. 1920. Pp. 110. 5s. net.
11. **ELEMENTARY NOTES ON THE SYSTEMATY OF ANGIOSPERMS**, by A. H. CHURCH. 1921. Thirty-four Lecture and Laboratory Schedules, arranged as Introduction to the Study of Flowers. Pp. 71. 3s. 6d. net.
12. **INTRODUCTION TO THE SYSTEMATY OF INDIAN TREES**, by A. H. CHURCH. 1921. Sixteen Lecture Schedules. Pp. 50. 2s. 6d. net.



QK  
490  
I405  
cop.2

Church, Arthur Henry  
Introduction to the  
systematy of Indian trees

**BioMed**

UNIVERSITY OF TORONTO LIBRARY

